A PRIMER ON AN APPROACH TO PLANNING AND PRODUCTION CONTROL FOR THE SMALLER SHIPYARD

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A PRIMER

ON AN APPROACH TO

PLANNING AND PRODUCTION CONTROL FOR THE SMALLER SHIPYARD

FIRST EDITION

DECEMBER 1983

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For The

SHIP PRODUCIBILITY RESEARCH PROGRAM

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EXECUTIVE SUMMARY

A PRIMER ON AN APPROACH TO PLANNING AND PRODUCTION CONTROL FOR THE SMALLER SHIPYARD

Many smaller shipyards are currently struggling to survive in the marketplace. Most shipyard managers recognize that improving the productivity of the production labor force is sorely needed. Direct attempts at improvement are often frustrated, or produce only short-lived advantages. Use of a larger whip usually antagonizes the situation and makes improvement even less likely in the long run.

Clearly, a different focus may be the key to success. Production workers receive considerable support from other segments of the shipyard. They are furnished with plans, work packages, facilities, tools, work places, material, and similar items indispensable to accomplishing the work. If these items of support are missing, or confusing to the worker, or arrive late, or are in unusable condition, or otherwise do not provide the vital support needed, then there is little that the production worker can do about it other than gird himself for an onslaught of criticism about his productivity.

A different focus promptly suggests two basic possibilities:

1) Most production workers <u>will</u> work if they have the opportunity to do so. Much of that opportunity, however, depends on capable support from other shipyard segments.

2) Other shipyard segments would provide improved support to the production worker if they understood what was needed and wanted. Their knowledge of the <u>real</u> productive process, however, may be seriously obscured by the limited visibility usually associated with production work.

A program of engineered labor standards can illuminate both sides of the question. Standards capture the true performance capability of the production worker under existing resource and support circumstances. The same standards are an effective vehicle for communicating this capability to those who support the production worker, so that they may design their support to be timely and effective.

Furthermore, standards allow objective and independent analyst: to identify where support is lacking or weak, enabling corrective action to take place. When changes are made, the standards are modified to capture the new situation. Before long the standards provide an auditable trail of productivity improvements which yields information of major value to shipyard management.

Several larger shipyards have been working to establish viable standards programs for several years. Planners, schedulers, industrial engineers, and production control people are using standards as tools to improve both the basic production function as well as the support provided to it in the form of plans, schedules, and related items. Smaller shipyards face a different problem because they may not have ~ in-house industrial engineers who can develop standards, and may not have the functions of planning, scheduling, and production control developed to the point where the application of standards would be helpful. The smaller shipyard must therefore start from square one and not only develop standards but also the capability to apply them effectively through good planning, scheduling, and production control.

Information developed under the Ship Producibility Research Program suggests that standards, particularly scheduling standards, can offer major advantages to the smaller shipyard striving to improve production performance, with only a modest investment in time and money. A 6-month pilot program conducted at one smaller shipyard provoked a throughput increase of 50% in a pipe fabrication shop. This throughput increase grew to 500% in the 18 months following the pilot, with the same number of production workers in the shop. The success achieved during and after this pilot program, along with several appeals for assistance from the smaller shipyard community, prompted the development of this Primer.

The Primer is designed to aid the smaller shipyard in understanding the basic features of planning, scheduling, and production control, along with how a standards program can provide the tools needed to achieve productivity improvements, Chapter 1 describes five typical smaller shipyards, to which others should be able to relate, and the problems that all five have in common. Chapter 2 defines the functions of planning, scheduling, and production control in basic terms, and explains techniques for gaining visibility of problem areas. Potential improvements are viewed from the standpoint of resources available to a shipyard - time, facilities, material, and manpower. Chapter 3 cites the improved prediction capability gained through use of engineered labor standards, and how it can aid the planning process. A family of standards is discussed, along with how each of the five types of standards is developed. The pilot project which explored the use of scheduling standards is described. Chapter 4 provides guidance for initiating a program leading to improved production performance through better planning, scheduling, and production control. The essential steps are discussed, along with sources of engineered standard data. The five typical smaller shipyards described earlier are used to illustrate how each might get started on a practical program. Chapter 5 lists sources of related information.

The information in this Primer is not a panacea. It describes only one of the tools which concerned shipyard managers can consider using in their thrust for productivity improvements. The visibility provided by a standards program, however, can be valuable in applying other tools which are being created under the National Shipbuilding Research Program through the Panels of the SNAME Ship Production Committee. For this reason, Chapter 5 includes a listing of all Panels, their areas of concern, and a contact point on each.

PREFACE

The National Shipbuilding Research Program is sponsored by the Maritime Administration United States Department of Transportation and by the United States Navy toward improving productivity in shipbuilding. Technical direction of this Program is provided by the Ship Production Committee of the Society of Naval Architects and Marine Engineers. The Ship Production Committee is composed of several Panels, one of which is the Panel on Industrial Engineering, SP-8 . The Industrial Engineering Panel and the Panel on Standards (sP-6) make up the Ship Producibility Research Program, managed by the Bath Iron Works Corporation, Bath, Maine.

In 1978, Panel SP-8 sponsored production of ~ Manual on Planning and Production Control for Shipyard Use* for the Ship Producibility Research Program. This Manual is a treatise on orienting the planning, scheduling, and production control functions squarely in line with the basic goal of the shipyard, which is to produce quality ships on time at a profit. The Manual -is based on research information gathered from the medium-to-large shipyard community, and presumes that a shipyard already has on-going programs for planning and industrial engineering matters. The Manual has been widely distributed to and well received by the targeted middle level managers and supervisors in the larger shipyards.

*Reference A in this Primer

Many of the smaller United States shipyards do not have any in-house industrial engineering capability, and indeed may have no identifiable planning, scheduling, and production control programs in place. They have therefore not been able to relate their circumstances to the points made in the original Manual. The management of several of these smaller shipyards requested development of a Primer to help them advance, from where they are today, to the point where they can begin to make use of the techniques described in the original Manual. The result is this Primer, which will be kept current with developments in the shipyard planning and production control areas as they occur and are relevant to the smaller shipyards.

The Primer contains suggestions for organizing, structuring, manning, and managing a group to initially introduce a program for improving planning and production control in a small-to-medium size shipyard. Ways to obtain and utilize engineered labor standard data toward improving the production planning function, work center loading, shop and shipyard scheduling and related functions are discussed. Current problems facing the smaller shipyards, with suggestions for their resolution, are included as appropriate.

Five examples of typical small-to-medium size shipyards are discussed in Chapter 1. Personnel from other small “shipyards reading this Primer should be able to relate their current situation to one or two of these examples. Later, in Chapter 4, implementation of the techniques suggested in this Primer is discussed in the context of each shipyard example.

Chapter 2 contains basic information on planning and production control, scheduling and shop work center loading in shipyards. Problems encountered in carrying out these functions are discussed in general terms. Chapter 3 describes a program of engineered labor standards, and how such a program can be useful at several levels of concern in a shipyard. Initiating, developing, and applying a standards program is treat-ed.

Chapter 4 presents an approach to establishing a program leading to the application of engineered labor standards for scheduling and shop work center loading, a good starting point for the smaller shipyard that currently has no equivalent program in place. Chapter 5 identifies several types and sources of assistance available to help an interested shipyard make use of the principles and techniques espoused in this Primer. As other avenues of assistance become available, they will be added to this Chapter in future editions.

This Primer was authored by Rodney A. Robinson, Executive Staff Member of Corporate-Tech Planning, Inc., Portsmouth, New Hampshire, and Waltham, Massa-chusetts. It is a result of research c&ducted as Task EC-16 of the Ship Producibility Research Program. It was begun in January and completed in December 1983.

Special acknowledgement is given the several industry representatives who contributed information on their particular shipyard organization and functional arrangement, to those who reviewed the First Edition and provided helpful comments and suggestions.

CHAPTER 1

ORGANIZATION OF SMALLER SHIPYARDS

BRIEF

Smaller shipyards differ in organizational and functional arrangements, but have several problem areas in common which inhibit effective management of the productive process. Five examples of smaller shipyards are described. Common concerns of collecting labor expenditure information by time cards, estimating the labor content of future jobs, scheduling production work, and appraising productive performance are discussed.

ORGANIZATION OF SMALLER SHIPYARDS

1.0 Organization of Smaller Shipyards

As background information for the starting point of this Primer, several smaller shipyards were investigated to determine their present disposition - organizationally and functionally. Results were somewhat unexpected, in that there is no common organizational structure among smaller shipyards as is generally found among larger shipyards. Although similar functions are performed in each of the smaller shipyards, these functions are carried out from different organizational locations by people of differing backgrounds and expertise. In short, the organizational and functional arrangement in each small shipyard simply reflects the particular assemblage of people and talent who make up that shipyard.

This situation is illustrated by the following five examples of small shipyards, beginning with the smallest. (Later on in Chapter 4 of this Primer, each shipyard example given here is reintroduced and discussed relative to how that shipyard might approach the development and "implementation of production oriented planning).

1.1 Shipyard Example No. 1

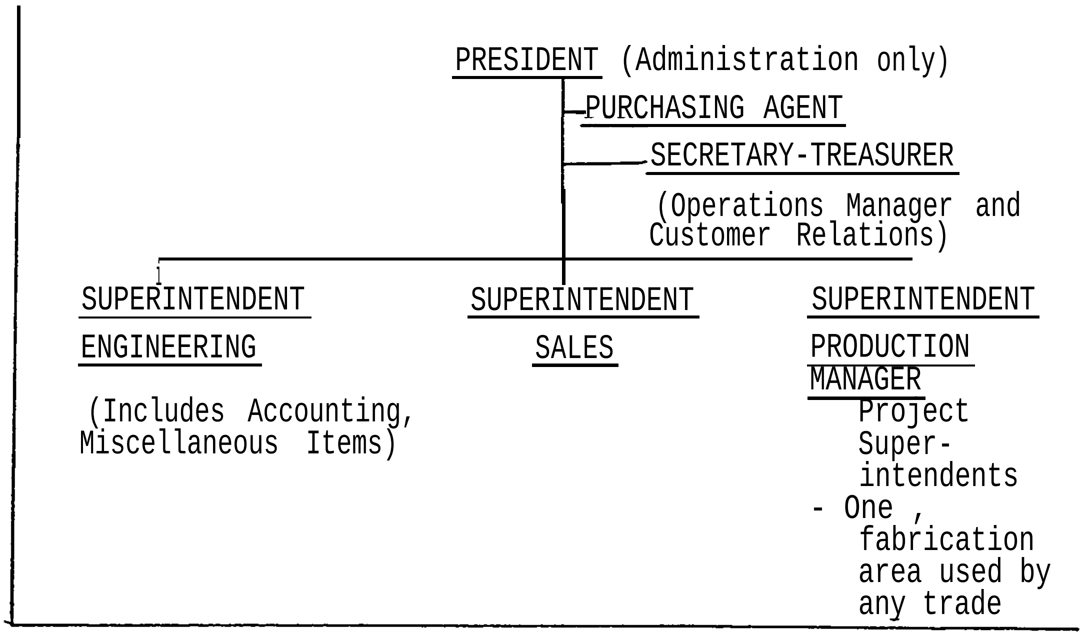

FIGURE 1-1: Shipyard Example No. 1

Major points of interest:

- Independent, owner-operated. Non-Union. Repair work only. About 100 workers. Four floating drydocks. No space or desire for synchrolift or rails. Electrical work and heavy machine work contracted out.

- Time Cards:
  Clocked in and out for attendance record.
  Foreman enters actual job(s) worked on each shift.
  Cards are collected daily.
  Occasional review by Assistant to SUPERINTENDENT PRODUCTION MANAGER.

Daily printout of labor expenditures (from time cards) available to any interested manager or supervisor.

- Estimating based on historical data from similar jobs, modified by actual conditions of steel plates, fairing, etc. of ship undergoing repair. No labor standards; only experienced estimators.
- Hours are allocated to individual jobs within a project for larger projects only. Return costs are then reviewed against these allowances. (Overall costs come in quite close to expectations, but the individual jobs within a project are often missed by a large margin) .
- Schedules:

  Prepared and used only for larger jobs (10,000 manhours or more) or for peculiar jobs unfamiliar to the workforce.

  Made up by Project Superintendent with assistance from SUPERINTENDENT ENGINEERING.
- Manpower assignments made each morning by the SUPERINTENDENT PRODUCTION MANAGER and his assistants. Workers are drawn from a labor pool and are assigned to a specific project/job. (Unassigned workers are sent home) .
- Meetings:

  No regular meetings of shipyard managers/ supervisors.

  Might have production meetings for large conversions (50,000 manhours or more) .

  Production-only meetings usually held weekly (pep-talk type).

- The relatively small amount of new material needed is procured by a purchasing agent directly under PRESIDENT.

1.2 Shipyard Example No. 2

PRESIDENT AND
GENERAL MANAGER

DESIGN/PLANNING
- Engineering
- Accounting

PRODUCTION MANAGER
- Foremen
- Pipe Shop
- Fabrication Shop
- Blast/Paint Shop
- Electrical Shop (Small)
- Mold Loft (Small)
- Plate Line (Small)

PERSONNEL
DIRECTOR

FIGURE 1-2: Shipyard Example No. 2

Major points of interest:

- Subsidiary of larger company. Non-Union. New construction (about 300 workers) and repair (about 50 workers). Two drydocks. Ships built in drydocks (no other work location for a whole ship).

- Time Cards:

    No time clocks.

    Foreman enters accounting information on time cards at the end of each shift.

    Parent organization processes time cards, and provides a daily labor distribution printout which is available to the Shop Heads and Foremen.

- Estimating based on historical data from similar jobs. No labor standards.

- A sequence chart is made for each general area of the ship, showing the 12 to 15 major events that will take place within each area and their precedence relationships. A few events may be broken down further to accommodate installation of grab rails, bits, etc. Manhours are then added to the entries on each sequence chart. (Occasional attempts to match expenditures against predicted manhours yield erratic results) .

- Schedules:

  No schedules, per se, only sequences of major events.

  General schedule of events determined informally by discussions between PRODUCTION MANAGER and GENERAL MANAGER with some input from DESIGN/PLANNING.

- Meetings:

  No regular meetings of shipyard managers/ supervisors for workload/sales/etc.

  PRODUCTION MANAGER conducts weekly meeting of <u>all</u> production people.

- Material procured by purchasing agent under PRODUCTION MANAGER.

1.3 Shipyard Example No. 3

PRESIDENT

- ADMINISTRATION
  - Materials Manager (Warehousing, Purchasing)
- ENGINEERING MANAGER
- OPERATIONS MANAGER
  - Production
    - New Construction Superintendent
    - Repair Superintendent
    - Operations Planning with Project Coordinators
    - Fabrication Shop
    - Carpenter Shop
    - Electrical Shop
    - Maintenance Shop
- SALES MANAGER
- MARKETING

FIGURE 1-3: Shipyard Example No. 3

Major points of interest:

- Subsidiary of larger company. Non-Union. Both new construction and repair (350 workers) .

- Time Cards:

  Clocked in and out for attendance record.

  Supervisor enters actual job(s) worked on each shift.

  Cards are collected daily.

  Daily printout of labor expenditures, broken down to the individual worker. Printouts are available to any interested manager or supervisor.

- Operations Planning produces work orders which include an estimate of the manhours required and the time frame (calendar dates) when the work should be performed. No labor standards.

- Percent completion determined weekly by visual assessment made by one man.

- Schedules:

  No schedules, per se; scheduled dates for work performance are included on each work order.

  Bar chart of all major work produced at the beginning of a project to aid in determining the intended work performance dates for each work order.

- Meetings:

  Regular meeting of all employees at 9AM each day.

  Project meeting on Monday mornings among Project Coordinators and Purchasing. Minutes are kept and distributed to all attendees. Problems from last meeting are reviewed. New problems are presented. Meeting is for information exchange, not problem solving.

1.4 Shipyard Example No. 4

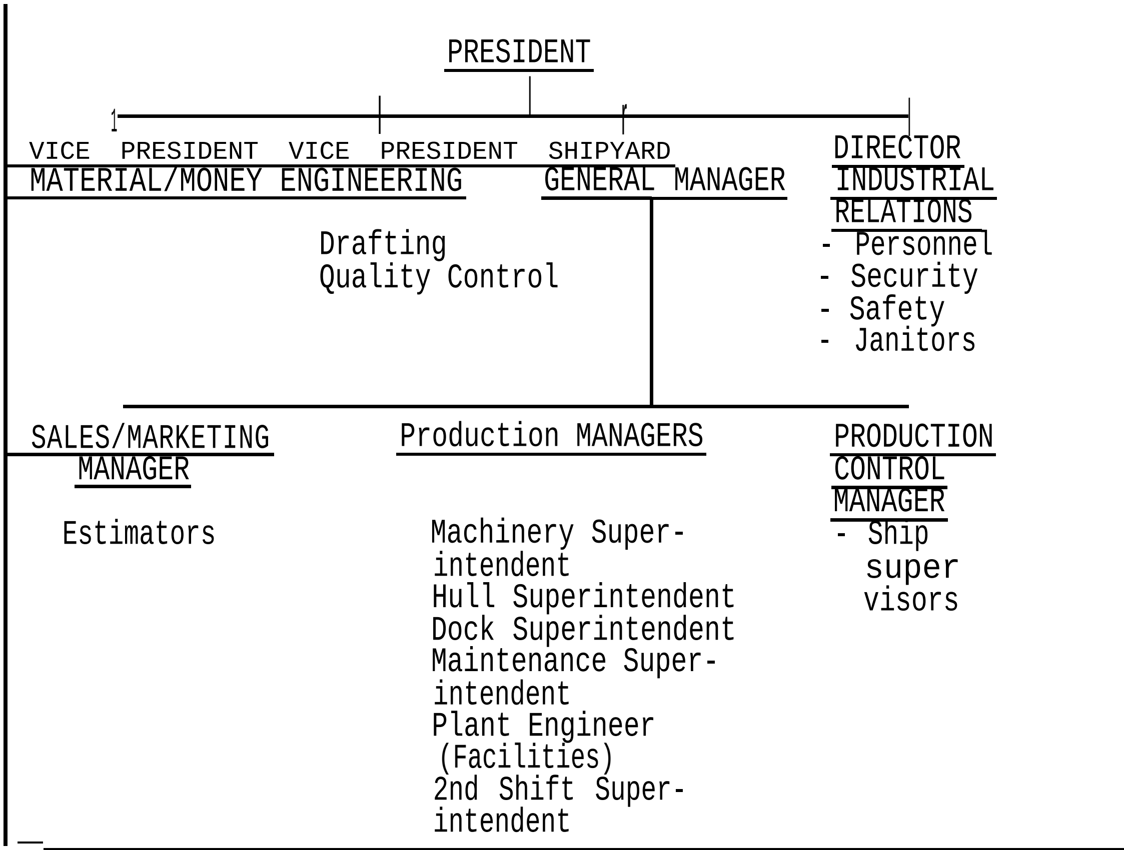

FIGURE 1-4: Shipyard Example No. 4

Major points of interest:

- Subsidiary of larger company. Non-union. Ship repair (about 200 workers). Synchrolift, and wheel-and-track transfer system. Extensive data processing system, mostly on-line using computer equipment available at or through the parent organization.

- Time Cards:

  Computer-supported attendance and job expenditure collection system.

  Each worker has a personal plastic card which is used through a computer terminal near his workplace to enter his attendance and the specific job being worked.

  Extensive worker time and job expenditure information available from data processing system, such as employees by craft/trade working on a specific work item. This information is available to any interested manager or supervisor.

- Estimating based on historical data from other similar jobs using information from the data processing system. Manhours are added to each work order, along with start and complete dates for each" work item. No labor standards. Note: Normal practice (prior to data processing system which is relatively new) was to produce a paper plan with major milestones, a sequence of individual work items with time intervals added to reflect the expected actual performance of each work item and a profile of the number of workers needed to do the work. Overall manhour loading was known quite accurately, but the individual work item breakdown was only estimated.

- Schedules:

  Schedule information available from data processing system, such as a job summary by each trade supervisor showing lead craft, budgeted hours, actual hours expended, projected hours to complete, percent of budget, percent complete, budgeted material cost, actual material charged, percent of material budget, equipment charges, and total price for the work item.

Every job in the shipyard is listed daily, along with how many people are working on each job and their physical location in the shipyard.

- Meetings:

  Daily production meeting conducted by the PRODUCTION MANAGER and the PRODUCTION CONTROL WAGER. QUALITY ASSURANCE, Safety, shop supervision, etc. attend.

1.5 Shipyard Example No. 5

PRESIDENT

VICE PRESIDENT FINANCE | VICE PRESIDENT SALES | DIRECTOR ENGINEERING | VICE PRESIDENT PRODUCTION | DIRECTOR PURCHASING | MANAGER PLANNING/ ESTIMATING

SHIPYARD MANAGER | SHIPYARD MANAGER (for second shipyard)

Personnel Manager | Safety Manager | Quality Assurance Manager | Warehousing Function

Production Manager (omitted with light workload)

Production Superintendents
- Pipe Superintendents
- Outfitting Superintendents
- Lofting Superintendents
(Foremen under Superintendents)
- 2nd Shift Manager

FIGURE 1.5: Shipyard Example No. 5

Major points of interest:

- Subsidiary of larger company. Non-union. New construction, about 500 people for each of two shipyards (varies from 250 to 620). Extensive computer support available through parent organization, although normally the shipyard has adequate computer capability of its own.

- Time Cards: - Clocked in and out for attendance record.
  Mechanic enters . actual job(s) worked with help from the Foreman. Three-digit charge numbers are used.
  Cards are collected daily.
  Daily printout of labor expenditures (from time cards) is available to interested managers and supervisors, but twice-a-week or weekly issue of labor expenditures information is more common.

- Design:
  Basic design purchased from an outside source.
  Breakdown of the design made within the shipyard as may be necessary. Repetitive projects receive a fine breakdown (to the level of an individual page for each panel, etc.) whereas one-time projects receive little or no breakdown. The degree of breakdown is decided ahead of time through discussions among Engineering, Planning, and Production.
  No computer-aided design or computer-aided manufacturing in place or anticipated.
  Engineering, Planning, and Production collaborate in detail on what should be produced for Production to use. Planning makes the first cut, on which Production provides

comments. Then changes and adjustments are made until agreement is reached via this group effort.

- Estimating based on historical data from similar jobs and on experience. Labor standards available only in the welding area. This area was selected as the best and easiest place to begin developing labor standards. Welding labor standards are based on historical data and experience (not on MTM[1] or formal work sampling). Each standard is then qualified in actual shipyard work. Production people agree with each standard before it is issued for use. When they are available, labor standards are used for estimating and budgeting.

- Production and Planning collaborate on the overall work plan for a project (whether to outfit before landing on the hull, etc.) usually even before a sales estimate is made. Work is then broken down via a 3-digit charge system (common to several similarly-sized shipyards). Design drawings are broken down into the same pieces. Planners then produce the overall plan and add budgets to each piece of work. Work orders are then produced, sized to be opened and closed within two weeks.

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[1] Methods-Time Measurement is composed of operational analysis techniques which have been objectively developed through the establishment of clearly defined actions for performing physical work, and accompanied by the corresponding time intervals within which a person can reasonably be expected to perform that work. MTM is discussed further in Chapter 4.

These work orders form the basis for subsequent schedules. Total work orders for a project may number from 15 to 60, depending on the size and duration of the project.

- Schedules:

  Prepared for each project. The general approach is to prepare a sequence of events, and then add the estimated times to each event, which forms the schedule.

  A Master Schedule covers start of fabrication through to delivery, and consists of about 25 items.

  Each item on the master schedule is broken down into its individual work orders. A six-week slice of the master schedule showing the constituent work orders is published every four weeks. Performance against this six-week slice is tracked and reported weekly. Certain events (like tank testing) may be broken down more finely than the usual six-weeks worth every four weeks.

  Bar charts of performance, planned and actual, are kept by Planning.

  Printouts are available to interested managers and supervisors showing all work orders, their budgets, and the status of work completion.

- Material:

  Steel Bill of Material prepared by Planning; all other Bills of Material prepared by Engineering and forwarded to Planning.

  Planning enters the need dates on the Bills of Material.

  Purchasing procures material according to the dates on the Bills of Material.

  Note that Warehousing is under the SHIPYARD MANAGER . (In some comparable shipyards, this function is under the DIRECTOR PURCHASING).

- Quality Assurance:

  Quality Assurance people inspect the work performed within each work order for compliance with specifications, contractual requirements, and customer acceptance demands. When found satisfactory, the work order is signed by Quality Assurance and forwarded to Planning for “closeout.

  Note: This shipyard is working toward establishment of a basic quality level for each type of work. planning will specify the requisite level of inspection in manuals, instructions, and standing procedures. Such a quality basis will aid in satisfying customer and specification requirements, and eventually avoid multi-levels of inspections, which can become confusing and costly.

- Meetings:

  No regular meetings.

  Most meetings are called when considered necessary by MANAGER PLANNING/ESTIMATING, although the SHIPYARD MANAGER sometimes decides that a meeting is needed. Other managers are entitled to call a meeting whenever they wish, but seldom do so.

1.6 Common Concerns

Certain features of each shipyard described above are quite similar, although the organizational location and talent of the people involved in that function may differ widely. The similar items of prime concern to the subject of planning and production control are: time cards; estimating; scheduling; and performance appraisal. These are discussed below.

a. Time Cards

Each shipyard relies on a time card system for labor expenditure information. Whether the system is simple and manual, or sophisticated and computer-assisted, inaccuracies in the basic input information undoubtedly plague each system. Well-intentioned supervisors or workers may enter charges that differ from the true and actual labor expenditures. When aggregated these inaccuracies can amplify and distort the true picture on an individual work order by large and misleading proportions. Unless there is a parallel system to illuminate at least some of these inaccuracies, the information captured cannot be qualified, and use of it must be tempered accordingly.

b. Estimating

A primary use of labor expenditure information in each shipyard example is in estimating the labor content of similar jobs in the future. Immediately, problems with the time card system come to the fore, and obligate the estimators to use their experience and judgement to adjust the labor assessments for future work. In most small shipyards, and unfortunately even in many larger shipyards, historical information and experience are the only tools available to the estimators. As one shipyarder put it recently, “If we lost our experienced estimators, we would be dead!” Another aspect of the estimating problem is that the total manhours to complete a project usually can be estimated quite accurately, although the individual pieces of work that make up the total project defy accurate estimating. This is simply a case of individual errors being statistically balanced out, so that the whole is relatively unaffected by them. However, if the labor content of the pieces is not known, then the next task which faces the people who schedule the work and load the manpower to accomplish it becomes equally frustrated.

C. Scheduling

As seen from the shipyard examples above, the smallest shipyards simply have no schedules at all. Personal attention by management to every detail of performance is the substitute. With only a few people involved in a relatively close area, the word-of-mouth on-scene timing of events can be tolerated, although it may indeed be an inefficient and uneven way to operate. As a shipyard grows in size and workload, schedules begin to appear of necessity. The usual way to produce a schedule (even in the larger shipyard) is to develop a sequence of events, fit them into the time interval established as the contract performance period, and then add estimates of labor content and calendar time needed to perform each event until all events are accommodated, thereby forming the schedule. Poor estimates make poor schedules. Poor schedules, in turn, frustrate the introduction of support (plans/material/equipment/manpower) at the proper time and place. Without strong and timely support, the repeatability and performance efficiency of the entire production function is lowered - and this function is the most expensive function of them all.

d. <u>Performance Appraisal</u>

Efforts to determine trouble spots in performance so that corrective action can be applied are also impeded by the lack of accurate predictions of the labor content in each job. Performance appraisal is usually made by comparing actual output with a performance reference, expressed as a percentage. To illustrate:

$$\text{Performance on a job} = \frac{\text{reference manhours}}{\text{manhours actually used}} \times 100$$

When the performance reference is based on estimates produced only through historical labor expenditure information from time cards, tempered by the experience of the estimators, it becomes a doubtful reference at best. Inaccuracies in the time card entries introduce distortions that defy the most sincere efforts by experienced estimators to produce a reliable reference through the addition of experience factors. Generation of a performance reference, then, becomes more of an art than a science, and as such it cannot be verified by objective analyses. Consequently, performance appraisal becomes doubtful if not impossible because there is no credible reference against which actual performance can be assessed.

In the smaller shipyards, performance appraisal is made through on-scene observations by experienced production supervisors, followed by direct communications with the workers. Nothing else is available. As the shipyard workload grows, such personal attention becomes increasingly difficult to apply, and it becomes spasmotic and uneven. The comparison of actual cost returns against original estimates, tempered by percent completion evaluations, forms the next best method for management people to use in appraising performance. With so much doubt about the accuracy of the estimated reference, however, true performance appraisal by this technique becomes equally doubtful. Clearly, a reliable reference for the labor content of each job would be helpful.

CHAPTER 2

BASICS OF PLANNING AND PRODUCTION CONTROL

BRIEF

Effective shipyard management requires good planning, scheduling, and production control. The basic elements of these functions are described. Tools to aid in gaining visibility of problem areas are presented, including scatter diagrams and workload projections. These tools reveal that the basic difficulty may not be the most superficial one of poor production performance, but may stem from inadequate planning and scheduling, a much more insidious cause. Improvement possibilities are explored in light of the basic resources available in a shipyard - time, facilities, material, and manpower - concluding that manpower is the most promising resource area for near-future improvements.

BASICS OF PLANNING AND PRODUCTION CONTROL

2.0 Elements of Planning and Production Control

In their simplest form, the elements of Planning and Production Control are discussed below.

2.1 Planning

The term Planning, as used in the shipbuilding and ship repairing business, is the process of determining and prescribing the detailed course of action to be followed in order to achieve certain shipyard objectives. These general objectives are usually established by senior management in light of the forecasted major opportunities and obstacles facing that shipyard. Planning involves the intended application of basic resources (manpower, materials, facilities, and time) in order for the shipyard workforce to carry out a project. Planning usually considers and treats only a single project at one time, leaving the treatment of several projects within the same shipyard to the scheduling function which is carried out at a later date. Planning, then, is based on a <u>prediction</u> of the work content in each of many individual tasks (each called a work order or a work package) which collectively make up that project. Based on this prediction, planning determines how, where, in what sequence and in what quantity each basic resource should be applied and expended. Planning becomes the basis for hiring and applying manpower, purchasing material and making it available to the workforce in the proper quantity at the right time and place with the requisite quality, utilizing old and procuring new facilities and equipment, and for most effectively utilizing the time available to complete the project.

The planning function may be carried out in any one or combination of several different organizational locations. It may be done in a group organizationally separated from production, such as under design, estimating, or operations management. It may be done within a separate group entirely under production management. It may be done in each individual shop or trade center under overall control and coordination of the production manager. It may be done by people who treat only planning matters, or it may be done by people who also handle scheduling and perhaps even some aspects of production control. The planning process, however, usually treats only one project at a time, and becomes the basis for the subsequent scheduling of all projects through consideration of the total shipyard resources available, as discussed below.

2.2 Scheduling

Scheduling is the process of assigning calendar dates to a sequence of events produced by the planning function for each individual project. Scheduling must consider the collective impact of all the individual projects on the total resources of the shipyard, and then assign calendar dates to the performance of each individual task or increment of work. Like planning, scheduling is also based upon a prediction of the work content of many individual tasks. The resulting schedule(s) are the basis upon which the support activities apply their input to shipyard operations so that the main production effort can be carried out efficiently and effectively. It is the basis on which shops are loaded with work and with manpower to accomplish that work. Whenever possible, shop loading is made as level as possible to avoid peaks and valleys in either workload or workforce, either of which produces an unbalance and inhibits efficient performance.

2.3 Production Control

Control of the productive process requires accurate information on what IS taking place in the shipyard, together with an accurate reference of what SHOULD be taking place. When these two items do not match, appropriate corrective measures are applied to bring them into closer agreement.

There are many detailed and often complicated functions performed under the heading of production control, but the basic thrust is as stated above. Success is directly dependent on having truthful and accurate information on current performance, along with a comprehensive reference based on (1) an assessment of the real work content of the project, and (2) a prediction of what production people will be able to actually produce under the given shipyard circumstances. All three of these basic ingredients are difficult to acquire in a shipyard.

Many other industries have a high volume of repeat tasks, with each task of short duration (perhaps only minutes long, or even seconds) . People who predict performance and assess the work content of various tasks in these industries have available to them a multitude of historical data. By applying statistical analyses and similar techniques to these data, a highly accurate basis for production control can be developed.

Shipyard work is more difficult to handle. It often consists of customized work orders that may never be repeated. Furthermore, the size of a typical shipyard task is much larger in manhours and longer in duration than the typical task in most other industries. Because of these different characteristics, a shipyard task may be sensitive to changes in overall shipyard resources that take place before the task is repeated. Changes in workload, workforce, facilities, materials, and the performance time window since the last performance period may substantially impact the use of historical data for predicting future performance under the new resource circumstances. In addition, the ever-changing environmental, supervisory, and managerial influences on the workforce must be considered. Unless historical data can be tempered to accommodate these effects,. it will be of little practical use in predicting future performance.

2.4 Scatter Diagrams

An effective production control system must compare planning allowances (labor budgets) with actual production expenditures. A useful technique for making this comparison is the scatter diagram (Figure 2-l). When expenditures closely match allowances, the dots hug the diagonal target (Figure 2-2).

A scatter diagram depicting an actual situation in a shipyard is shown in Figure 2-3. This erratic dispersion is open to two interpretations:

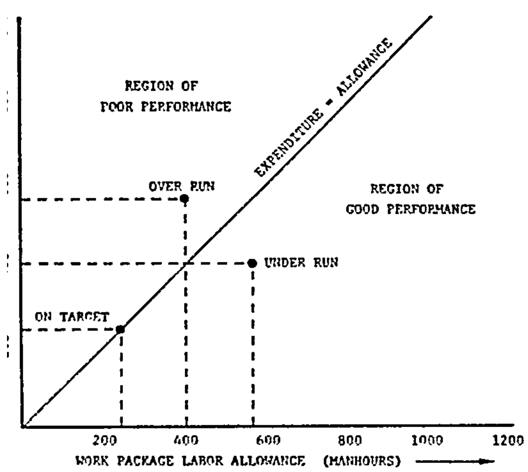


FIGURE 2-1: SCATTER DIAGRAM - A TOOL FOR MONITORING PERFORMANCE

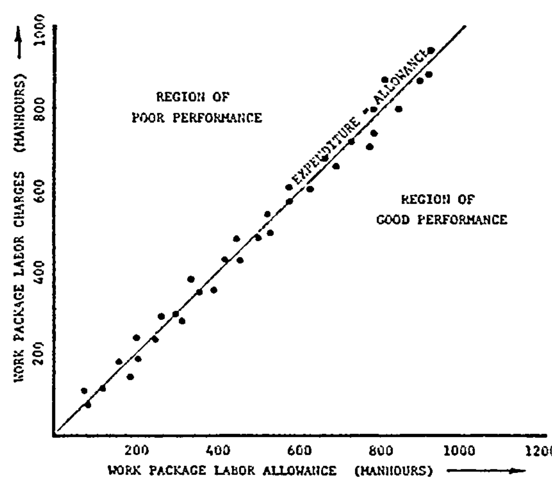


FIGURE 2-2: SCATTER DIAGRAM - GOOD PERFORMANCE

(1) Shop performance is inconsistent, with a bias toward budget overrun, or

(2) Planning allowances are inconsistent, with a bias toward underestimating the real work content of the job.

Information developed through research sponsored by SNAME Ship Production Committee Panel SP-8 tends to support the second interpretation (Figure 2-4) ; namely, that shop performance is essentially consistent while planning is not. This is not to say that shop performance is as good as it might be, but simply that it is consistent.

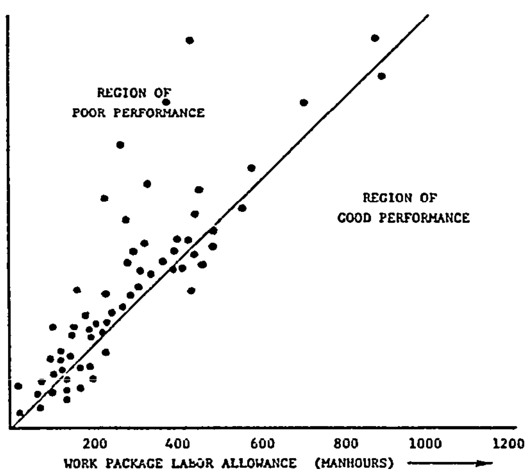


FIGURE 2.3: SCATTER DIAGRAM - THREE ACTUAL SHOPS

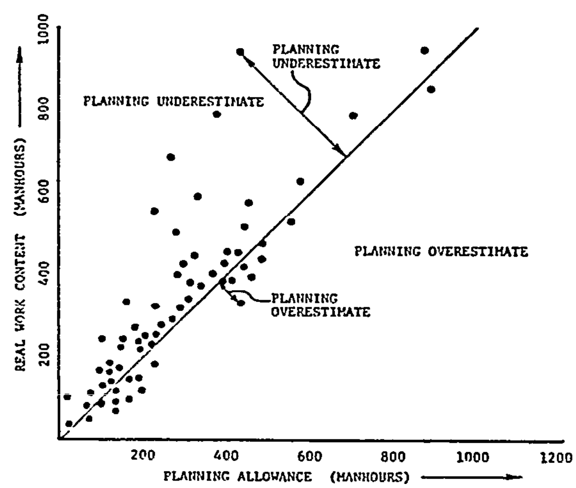


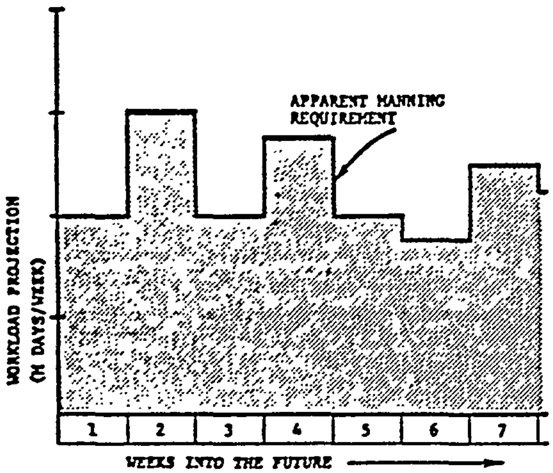
FIGURE 2-4: SCATTER DIAGRAM - A VIEW OF PLANNING

2.5 Workload Projections

A shop schedule is based on the perceived workload as interpreted by planning for the shop (Figure 2-5). If planning estimates are inconsistent, the real workload might truly be as shown in Figure 2-6. This can create two situations in the shop: periods when there is too much work (e.g., overload, so work slips to a later date), and periods when there is too little work (Figure 2-7).

To illustrate the first situation, Week 1 is undermanned to handle the real workload, and so an overload results. This overload work carries over into Weeks 2 and 3 where there is excess manning to suit the real workload, and the carried-over work is performed late. To illustrate the second situation, Weeks 2, 3, and 4 have excess manning relative to the real work-load. Some of this excess capacity is utilized in performing late work carried over from Week 1, but the remainder of this excess capacity (half of that in Week 3 and all in Week 4) will simply result in excess charges.

These excess charges occur because all production labor must be charged somewhere, and usually directly to a production job. The underload condition often results in worker time being charged to jobs that are not even worked, which generates a double bias toward lateness and overbudget (manhours are expended but no corresponding work is produced). In addition, labor expenditure data is now an inaccurate basis for



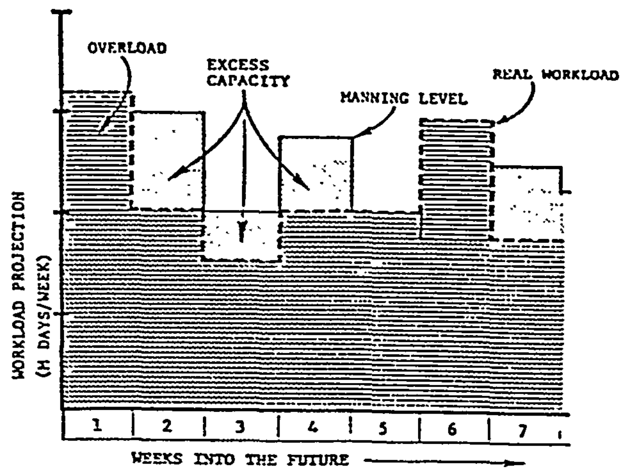
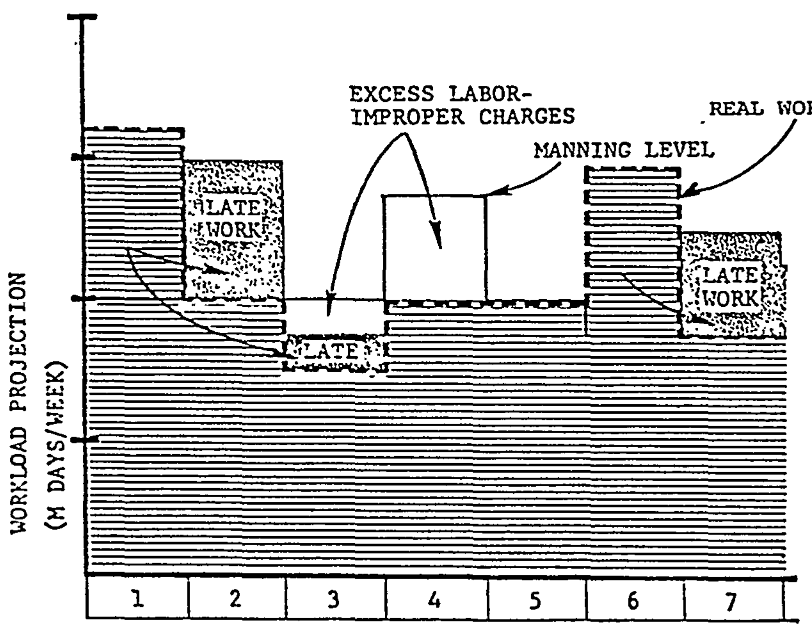


FIGURE 2-5: WORKLOAD PROJECTION FROM WORK PACKAGE ALLOWANCES

FIGURE 2-6: WORKLOAD PROJECTION - ACTUAL VS PLANNED



W E E K S I N T O T H E F U T U R E - - - - - - >

FIGURE 2-7: WORKLOAD PROJECTION IMPACT OF UNRELIABLE ALLOWANCES

predicting future performance. Note at this point that the basic cause of inaccurate time card entries is the lack of balance between workforce and workload. If this cause is lessened or eliminated through a proper workforce/workload balance, time card entries will quickly become more accurate and reliable because the motivation for mischarging will shrink and. eventually disappear.

Clearly a set of tools is needed that will be helpful in providing consistent and realistic planning estimates and allowances. One such set of tools consists of engineered labor standards as discussed in Chapter 3. Earlier work under the Ship Producibility Research Program (References B and C) illustrates that substantial improvement in schedule adherence can be realized through use of engineered labor standards, because planning is better able to predict the actual work content of the jobs involved and production can man the work centers accordingly. (Chapter 3 discusses the types of engineered labor standards that constitute an effective family of these tools~ how these standards can be obtained, and the application possibilities for each type of standard.)

2.6 Improvement Possibilities

The determination of what should be done to improve the performance of a shipyard must be judged in light of what CAN be done. In which areas corrective actions should first be applied must also be carefully assessed. In approaching these questions, consider the four basic resources available in a shipyard - time, fZtCilitieS, material, and manpower - and which Of these resources offer the most opportunity for management adjustment to enhance shipyard performance improvement.

a. Time. The number of weeks or months available to build or repair a ship is normally specified in the contract as the Contract Performance Period. The time available may be adequate, or may be too short. Once the contract is signed, however, there is usually little or no latitude available for adjustment. The shipyard simply has to perform within the time limits established in the contract. A more accurate prediction of the time period truly needed to get the work done under the existing shipyard resource constraints may be helpful to the contracting people in negotiating the next contract, but the shipyard cannot do much about the existing time boundaries once the contract is signed. Time, then, is a resource about which little can be done by shipyard managers in the immediate future.

b. Facilities. The facilities already in existence at the start of a contract are generally the ones that must be used. The process of funding and obtaining new facilities or major alterations to existing facilities takes a relatively long time compared to the performance period of a typical shipyard contract. New facilities may help out <u>next</u> time, and certainly the generation of reliable scheduling data can point out facility bottlenecks and potential detours around them, but the basic facilities in place are essentially fixed for the duratj-on of a current contract. For this reason, it is often best to improve facilities <u>between</u> contracts rather than to disrupt on-going production work.

c. <u>Material</u>. Once a contract is established, the particular material types and quantities needed to do the work are usually defined by the contract. Some freedom to select and apply materials may be built into the contract, but most often material questions are answered in the contractual, agreement. What remains is for the shipyard to procure and apply those materials in the right condition, at the right place, and at the right time in the production process. If material is delivered to the worksite too soon, in-process storage and sorting problems will result. If material arrives too late, work will be delayed with accompanying domino effects downstream. Reliable scheduling data can avoid or at least minimize these material handling problems. The broader questions of material selection and procurement, however, often are beyond the control of shipyard managers once the contract is fixed.

d. <u>Manpower.</u> The resource on which shipyard managers can exert the most influence during an individual project is manpower. The largest and most expensive component of manpower is the productive labor force. Manpower considerations include applying overall shipyard requirements by craft all the way down to individual work order or work package requirements. Accurate workload forecasting coupled with accurate predictions of manpower capabilities will permit the proper application of work packages and manpower so that the work <u>load</u> and the work <u>force</u> are balanced, and the true capacity of the shipyard is effectively utilized. Once a proper balance is obtained, the load can be increased until the true capacity of the shop/craft is reached. The best performance will be realized at the point of <u>proper</u> load on the workforce with neither underload nor overload, either of which will prompt a slowing-down effect. At the point of proper balance, inaccurate time card entries will diminish, and the reliability of labor expenditure information from this source will substantially improve.

The manpower resource, then, should receive careful attention, because it is the most controllable by shipyard managers in the near-term future. Controlling the productive manpower resource provides a promising starting point for improving shipyard performance. With this in mind, consider the tools and techniques that are available to help in achieving these improvements. These tools are called engineered labor standards, as described in Chapter 3.

CHAPTER 3

<u>ENGINEERED LABOR STANDARDS</u>

BRIEF

Inability to predict the <u>real</u> work content of production jobs and how long it will take to perform them can seriously impact the planning, scheduling, and production performance functions. Engineered labor standards are effective tools for making such predictions accurately. A family of standards is described, with how they fit into the planning process. Standards development is discussed. Use of standards designed for scheduling. purposes is explored, including their actual development and use in a shipyard during a recent pilot project.

3.0 Engineered Labor Standards

An engineered labor standard describes the time and effort determined to be necessary for an average qualified worker to perform a defined amount of work under capable supervision using adequate equipment, material, and information under normal workday circumstances. A standards program suitable for shipyard use is described below.

3.1 Standards Hierarchy

Previous research efforts under SNAME Ship Production Committee Panel SP-8 have identified five levels of standards (Figure 3-1).[2] The most detailed and lowest level of standard is the Process Standard. The least detailed and highest level of standard is the Cost Estimating Standard. This family of standards derives from the same common base of engineered standard data.[3] These basic data can be combined in

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See A- Manual on Planning and Production Control for Shipyard Use, Reference A.

3 A substantial quantity of engineered standard data has been developed by several shipyards participating in the National Shipbuilding Research Program using the Maynard Operational Sequence Technique (MOST, a system developed by the H.B. Maynard Co.) . These data are contained in Work Management Manuals (WMM) for each trade/shop area involved as discussed in Chapter 4.

several ways for ease of application to different planning problems. A carefully developed audit trail is maintained from one level to the next.

- COST ESTIMATING STANDARDS
- PLANNING STANDARDS
- SCHEDULING STANDARDS
- PRODUCTION STANDARDS
- PROCESS STANDARDS

FIGURE 3-1: FAMILY OF STANDARDS

The standards in the family are characterized by the degree of accuracy expected, with the lowest level having the highest short term accuracy. There are also similarities among the levels in this standards family. Process, Production, Scheduling, Planning, and Cost Estimating Standards are based on the following common elements:

- Definition of the work method
- Statement of quality tolerances
- Degree of detail as determined by desired accuracy of results, by end use, and by information available to the user

a. Process Standards

Process Standards cover a single work process. For example, a standard might be developed to cover the hand burning process. The work covered would include: set up torch, change tips, coil/uncoil hose, adjust pressure, ignite, burn plates, pierce, contour, clean up, etc. The work covered by a Process Standard might be performed anywhere in the shipyard. When developing a Production Standard for burning plates, the work involved in carrying out the burning process (as captured in the burning Process Standard) would be combined with the content of other Process Standards which represent the rest of the work done by the burner (e.g., machine burning, off-loading the machine). Normally, Process Standards are used only to provide the data needed for Production Standards, or for cost comparisons involving that particular process (Figure 3-2).

USES :
- BASIC BUILDING BLOCK FOR OTHER STANDARDS AND FOR STANDARD DATA CHARTS
- COST COMPARISONS

UNITS :
- MANHOURS
- MACHINE HOURS (CREW SIZE)
- CONSUMABLES REQUIRED
- NORMAL SCRAP LOSS

FIGURE 3-2: PROCESS STANDARD

b. Production Standards

Production Standards cover the work content of a production job. They are created by combining several Process Standards. Production Standards show either standard manhours for individual workers, or machine hours and crew size for work centers, depending on the management control system in effect. Production Standards are used as a benchmark for measuring labor productivity and methods improvements (Figure 3-3) .

USES :
- PRODUCTIVITY MEASUREMENT
- METHODS IMPROVEMENTS
- BUILDING BLOCK FOR SCHEDULING STANDARDS

UNITS :
- MANHOURS
- MACHINE HOURS (CREW SIZE)

FIGURE 3-3: PRODUCTION STANDARD

c. Scheduling Standards

Scheduling Standards are formulated by combining several Production Standards, or by introducing certain allowances into Production Standards. This is the first level of standards intended for use outside of the industrial engineering area. One of the most important elements of the Scheduling Standard is the "non-process factors" which bring real world imperfections into the industrial engineer's best method (Figure 3-4). Schedulers and shop planners can use Scheduling Standards to determine elapsed time for certain operations or work stations. Scheduling Standards allow prescription of constant and level work center loading. Scheduling Standards provide data for developing the schedules that are used to measure production performance (Figure 3-5).

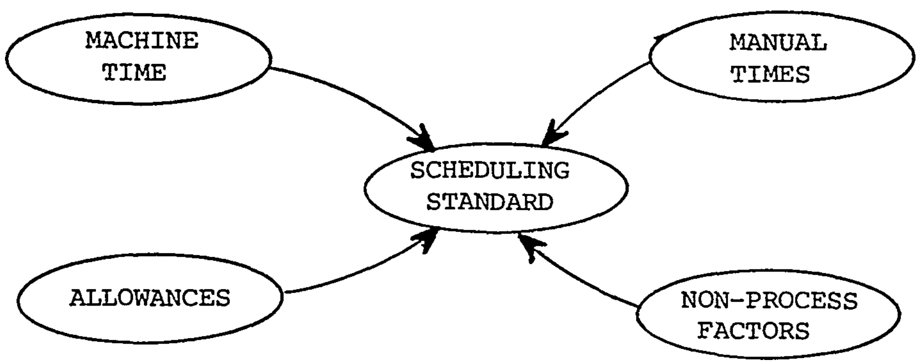

FIGURE 3-4: ELEMENTS OF A SCHEDULING STANDARD

USES :
- WORK CENTER BUDGETS
- WORK CENTER LOADING

UNITS :
- MANHOURS
- CREW SIZE
- DAYS DURATION

FIGURE 3-5: SCHEDULING STANDARD

d. Planning Standards

Planning Standards are less detailed than Scheduling, Production, or Process Standards. They are used for determining work package budgets. A central planning office can use Planning Standards to load the major shops or erection sites. The sequencing of work packages through the shipyard is accomplished using Planning Standards (Figure 3-6) .

USES :
- WORK PACKAGE BUDGETS
- SHOP LOADING
- SCHEDULE DEVELOPMENT

UNITS :
- MANHOURS
- CREW SIZE
- DAYS DURATION

FIGURE 3-6: PLANNING STANDARD

e. Cost Estimating Standards

The first use of the Cost Estimating Standards (Figure 3-7) is for Milestone and Key Event planning and sequencing. They show the preferred sequence of operations for carrying out a task. The relationship to other activities might be reflected in a standard network for producing a certain type or class of ship.

USES : • MILESTONE AND KEY EVENT PLANNING AND SEQUENCING

• OVERALL CONSTRUCTION STRATEGY

UNITS : • JOB SEQUENCE

FIGURE 3-7: COST ESTIMATING STANDARD FIRST USE

The second use of Cost Estimating Standards is to determine ship construction or repair costs for original bids, and for some change orders (Figure 3-8) .

USES : 0 NEW SHIP COST ESTIMATING

• CHANGE ORDER ESTIMATING

• SYSTEM COSTS ESTIMATING

UNITS : • TOTAL COSTS FOR LABOR, MATERIAL, FACILITIES, AND TIME

• DOLLARS, MANHOURS, DAYS

FIGURE 3-8: COST ESTIMATING STANDARD SECOND USE

They are applied when the information about the ship is incomplete. They are designed to minimize the time required to prepare cost estimates. Usually, cost Estimating Standards are cataloged by ship system, similar to the typical work breakdown structure used by most shipyards.

f. The Family of Standards

From the nature of standards development, different numbers of standards at each level are required (Figure 3-9). Even though the level of Process Standards is lower than that of Production Standards, their contents (as shown in Figure 3-10) are not as constrained as are those of a Production Standard. Therefore, there can be fewer Process Standards than there are Production Standards.

g. Cost Versus Accuracy

The whole intent of planning and scheduling based on engineered standards is to produce more accurate budgets and schedules. Care must be taken, however, to ensure that the cost of planning and scheduling using engineered standards does not exceed the benefits accrued. Accuracy must be kept within acceptable tolerance limits while applications costs are minimized (Figure 3-11).

h. Application versus Accuracy

The degree of absolute accuracy needed within a standard depends on the intended application of the 'standard. Process Standards and Production Standards to be applied for methods engineering or for the development of incentive pay scales must be accurate to perhaps ± 5%. By comparison, Scheduling Standards with an individual accuracy of ± 20% are quite satisfactory for shop or work center loading. Higher level standards generally can be less precise than the lower level standards from which they are developed, and will still be suitable for the higher level planning and cost estimating applications.

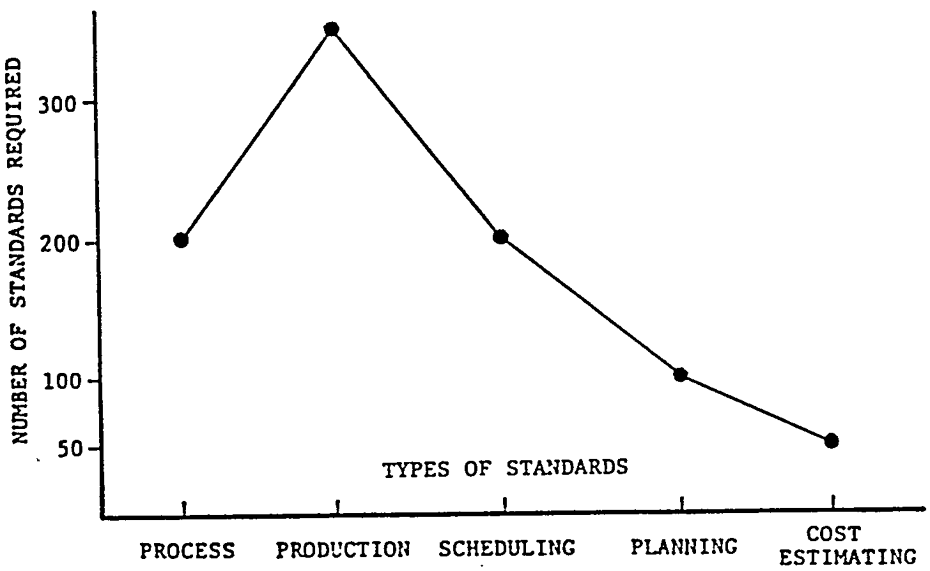

FIGURE 3-9: A FAMILY OF STANDARDS

FIGURE 3-10: STANDARDS CONTENT

DIFFERENT TYPES OF STANDARDS SHOW DIFFERENT ELEMENTS OF DETAIL (WELDING EXAMPLE SHOWN)

		ELEMENT CONTAINED IN THIS TYPE OF STANDARD				
ELEMENT	EXAMPLE	PROCESS	PRODUCTION	SCHEDULING	PLANNING	COST ESTIM
Type of Process	fluxcored,SMA,etc.	•	•	•		
Electrode	7016,7019,14",28"	•	•			
Type of Edge Prep	bevel	•	•		•	
Position	downhand,vertical	•	•			
Work Location	shop,ways		•	•	•	
Work Conditions	cramped,windy		•			
Fatigue Allowance		•				
Move Distances	walk 3'	•	•			
Material	primed steel,HY80	•	•			
Part of Ship	bow,stern,tank			•	•	•
System on Ship	steering gear,hyd			•	•	•
Scrap Loss	pounds in/out				•	•
Cost of Material	$/lb.					•
Cost of Electrode	$/lb.					•
Labor Rate	$/hr.					•

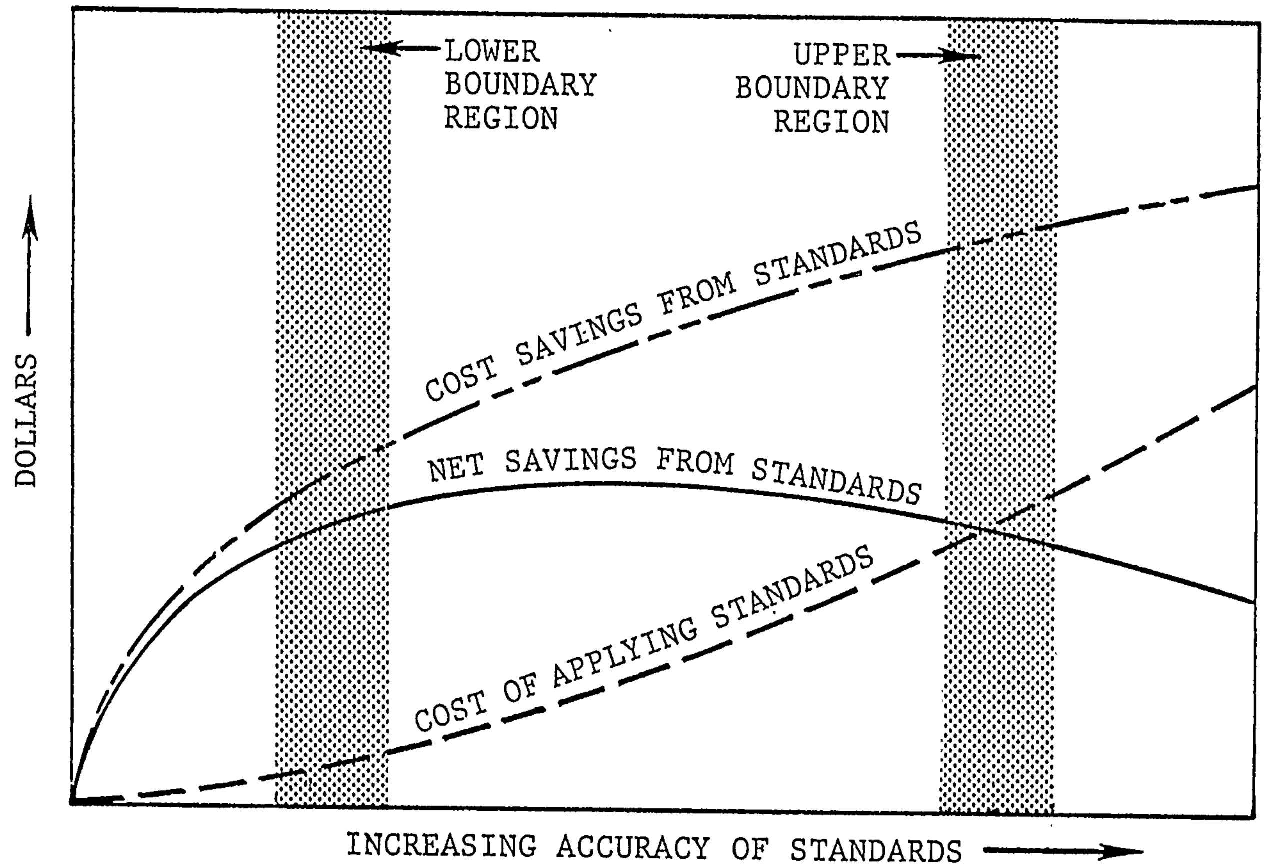

FIGURE 3-11: ECONOMICS OF STANDARDS APPLICATION

i.. Application versus Development

Development flow contrasts sharply with the way in which standards will be applied (or used) by those in the planning cycle. The flow of the planning process is from the top down; that is, information becomes more detailed as the process continues. The standard at a given level, therefore, must be compatible with the planning information at that level.

Before discussing the Development of Standards, consider the application possibilities within the Planning Process, and the particular type of standard best suited to each level of planning.

3.2 Planning Process

In the larger shipyards there are generally four working levels of planning (Figure 3-12). A fifth

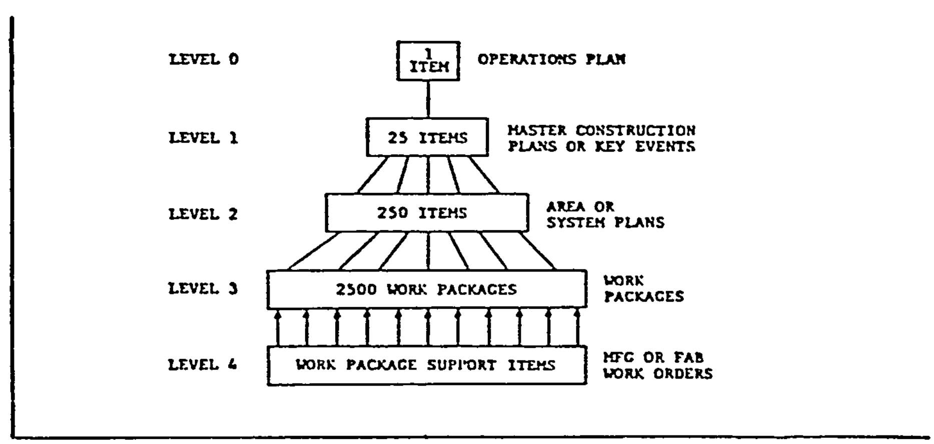

FIGURE 3-12: SIMPLIFIED PLANNING PYRAMID

level which could be called level O is sometimes introduced to accommodate the determinations made by senior management early in the bidding process. Only four levels will be discussed here.

a. Level 1 planning is accomplished by senior management. It deals with large segments of the ship and development of master construction or repair plans. The bid is prepared at this level.

b. Level 2 planning is usually accomplished by a project or planning management team. It deals with development of area or system plans including the block erection sequence and plan.

c. Level 3 planning is the first level of planning that is accomplished by a planning group. V?ork package budgets an shop loadings are developed at this level.

d. Level 4 planning is usually done by planners located in the shops. Work center loadings and schedules are developed at this lowest level of formal planning.

3.3 Standards/Planning Pyramid

When combined, the family of standards and the levels of planning form two sides of a pyramid (Figure 3-13). The two hidden sides depict the primary user and the primary usage. A three dimensional model can be made by cutting out Figure 3-14.

As can be seen from Figure 3-14, Process Standards form the bases for all other standards. production Standards are used for methods engineering and work measurement. The first level of standards that corresponds to a formal planning level is the Scheduling Standard, used by the shop planner for loading work centers. The Planning Standard accommodates Level 3 planning, where a central planning group develops work package budgets and shop . loads. cost Estimating Standards are tools used by senior management for the generation of bids and the development of key events.

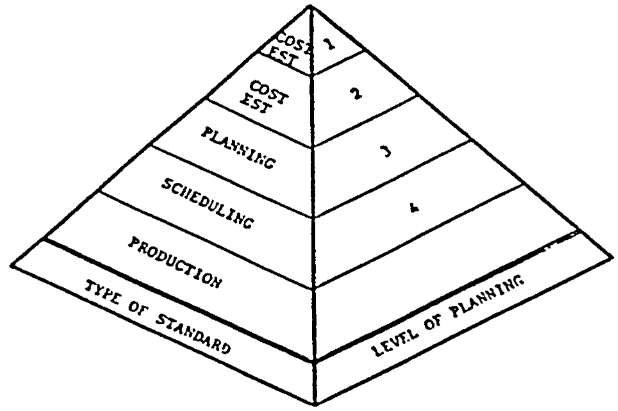

FIGURE 3-13: STANDARDS PLANNING PYRAMID

A planner should be able to readily apply a planning Standard to develop work package budgets and schedules based only on the information available to him through the planning process at that time. But to assure accuracy, Planning Standards must necessarily be based on a more detailed understanding of the production process itself. This leads to the main postulate of the standards/planning pyramid:

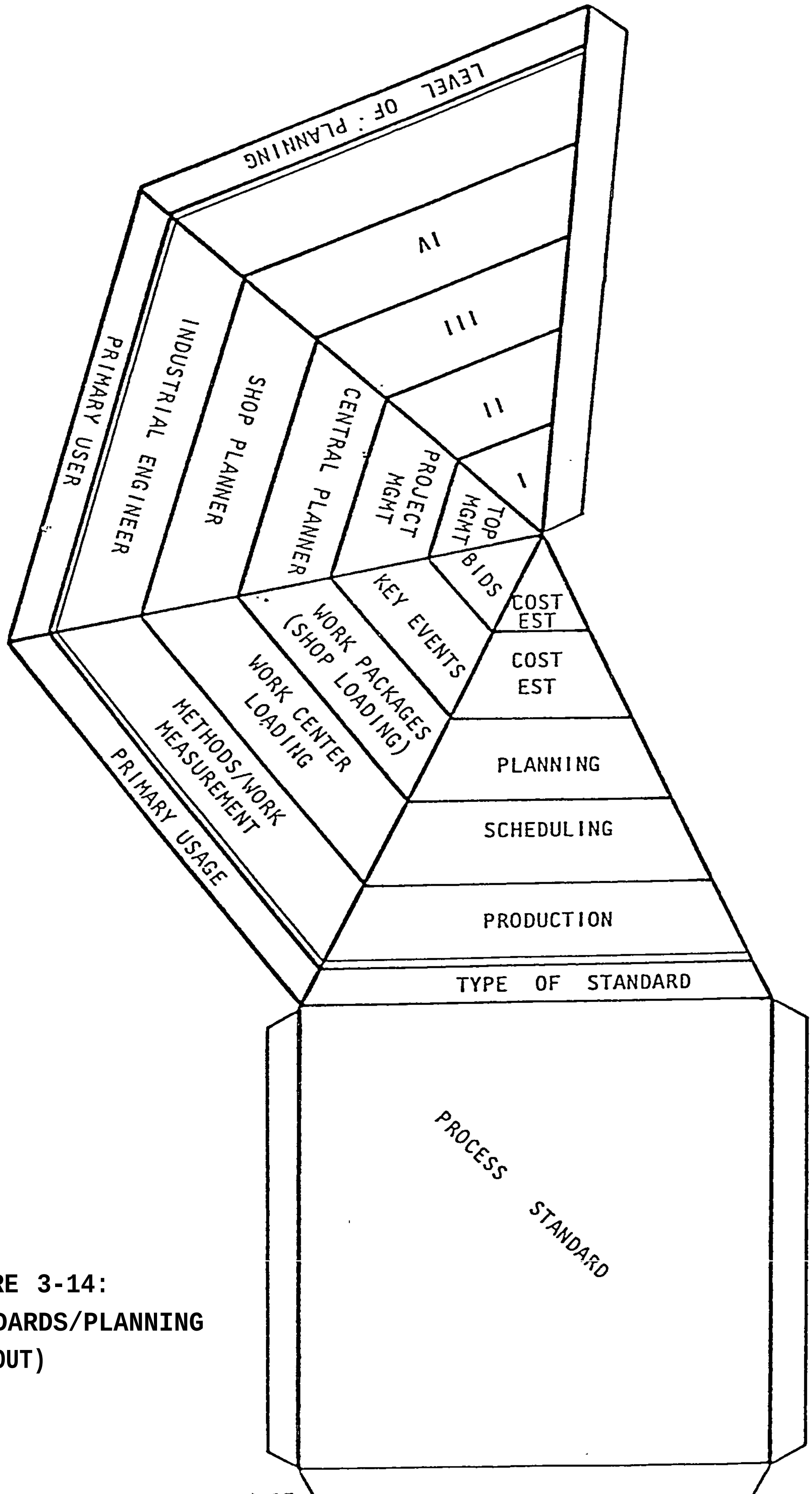

FIGURE 3-14: STANDARDS/PLANNING (CUTOUT)

Developing standards is operation/trade oriented
while
Applying standards is product/trade oriented

The standards development process is one that flows from the bottom up; that is, Process Standards are developed from standard (Work Management Manual) data; Production Standards are developed from Process Standards. This action continues up through the levels of the standards pyramid, combining and utilizing lower level (more detailed) information to develop higher level (less detailed) standards. The development of standards is usually carried out by industrial engineering personnel, or by people trained in the application of industrial engineering principles and techniques, because the technology involved is a normal part of the industrial engineering discipline.

3.4 Development Process

The base of the standards pyramid is the Process Standard. There is, however, a level of information even lower (more detailed) which consists of the standard (work Management Manual) data. Standard data then, is the first step in the standards development process (Figure 3-15). Up to and including the Production Standard, the development process is additive; that is, there is a direct relationship between the Production Standard and the Process Standard. This is shown by solid lines. Due to the non-additive properties of the higher level standards, their relationship is shown by dotted lines.

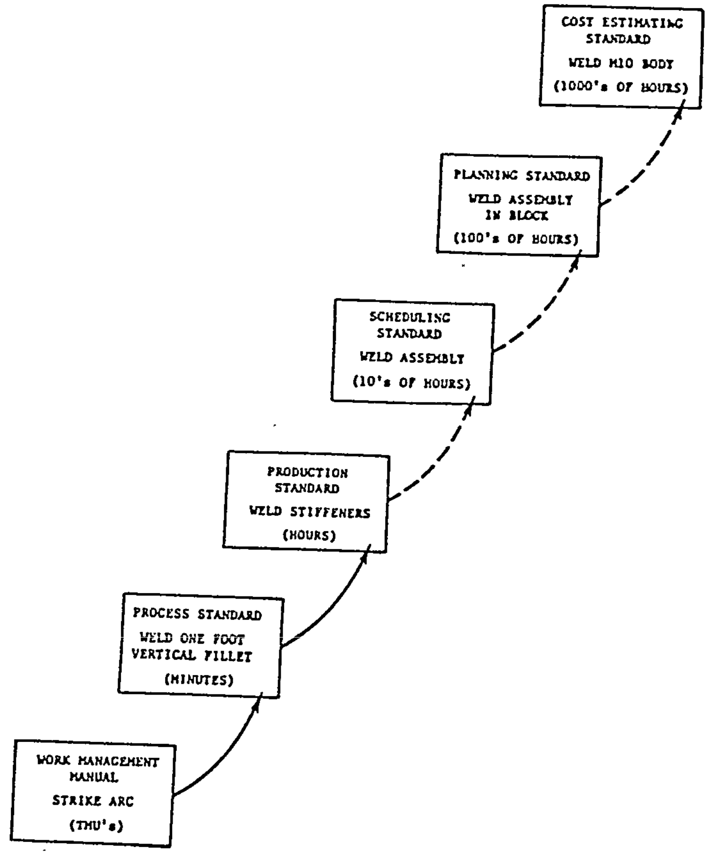

FIGURE 3-15: STANDARDS DEVELOPMENT PROCESS

Figure 3-16 depicts the separation of the development process from the end use. While there is a clear and auditable trail from Production Standards to Scheduling Standards (and beyond), the connection is not direct. The real building block for all upper level standards is, in fact, the Process Standard.

The major reason for no direct route from a Production Standard to a Scheduling Standard can be seen from the actual end use of each type of standard.

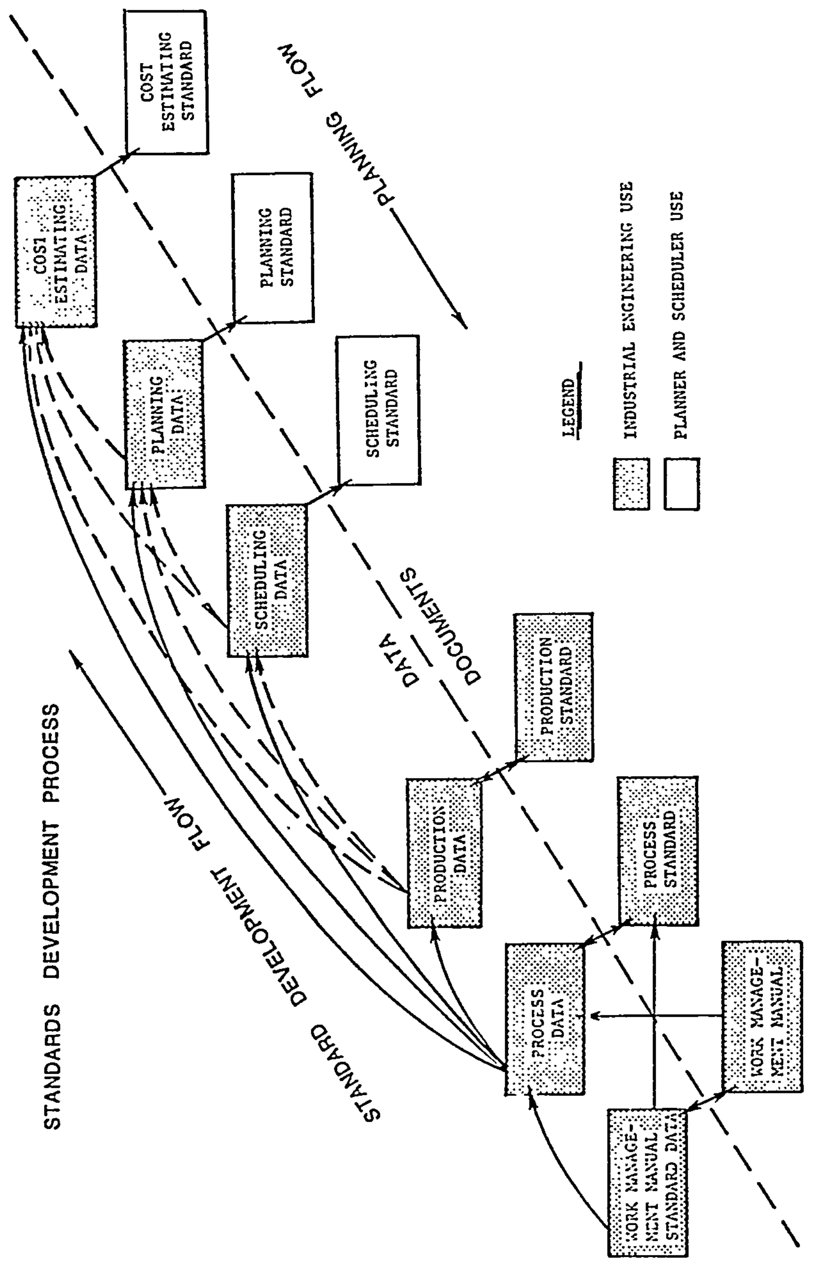

FIGURE 3-16: STANDARDS DEVELOPMENT FLOW VS. PLANNING FLOW

Production Standards and other lower level standards are used for methods engineering and work measurement. As such they are based on sound methods which do not allow for delays outside of those which are actually a part of the work method itself. Scheduling Standards and Planning Standards, on the other hand, are used to load work centers and shops. They must reflect all the work done to complete a job whether that work is part of an efficient method or not. The extra work, which must be included to reflect the real world, will be referred to as the non-process factors and will include such items as crane delays, waiting for assist trade, welding excessive gaps, etc. These non-process factors will differ in each work center and each shop, and may, in fact, differ for each piece of work. Even though the non-process factors differ from' area to area, they certainly can be reliably documented. Scheduling Standards and Planning Standards include these non-process factors and, therefore, realistically reflect what is actually happening in the shipyard.

3.5 Making a Scheduling Standard

Scheduling Standards offer the most promise for near-term improvements in applying the productive labor resource. There are four elements in the make-up of a Scheduling Standard: manual time, machine time, allowances, and non-process factors (Figure 3-17) .

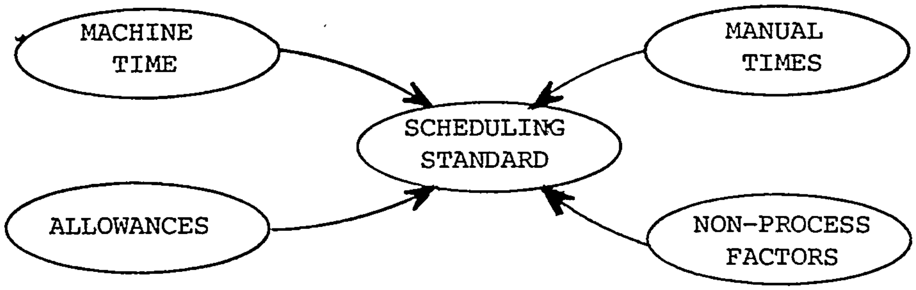

FIGURE 3-17: ELEMENTS OF A SCHEDULING STANDARD

a. Use of Standard Data

The manual time, machine time (e.g., welding arc time), and allowances are included in the standard (Work Management Manual) data. Usually, to make future development easier, these standard data will be combined in various ways to create a library of Process Standards. It is from this catalogue of standard data and Process Standards that the actual work methods and work environment are captured.

b. Scheduling Standard Development

The steps involved in making a Scheduling Standard are shown by Figure 3-18. As can be seen from this flow diagram, both planning and production must cooperate closely with those providing the industrial engineering input so that the end result will be a usable document that accurately reflects the real work content of the jobs involv-

MAKING A SCHEDULING STANDARD

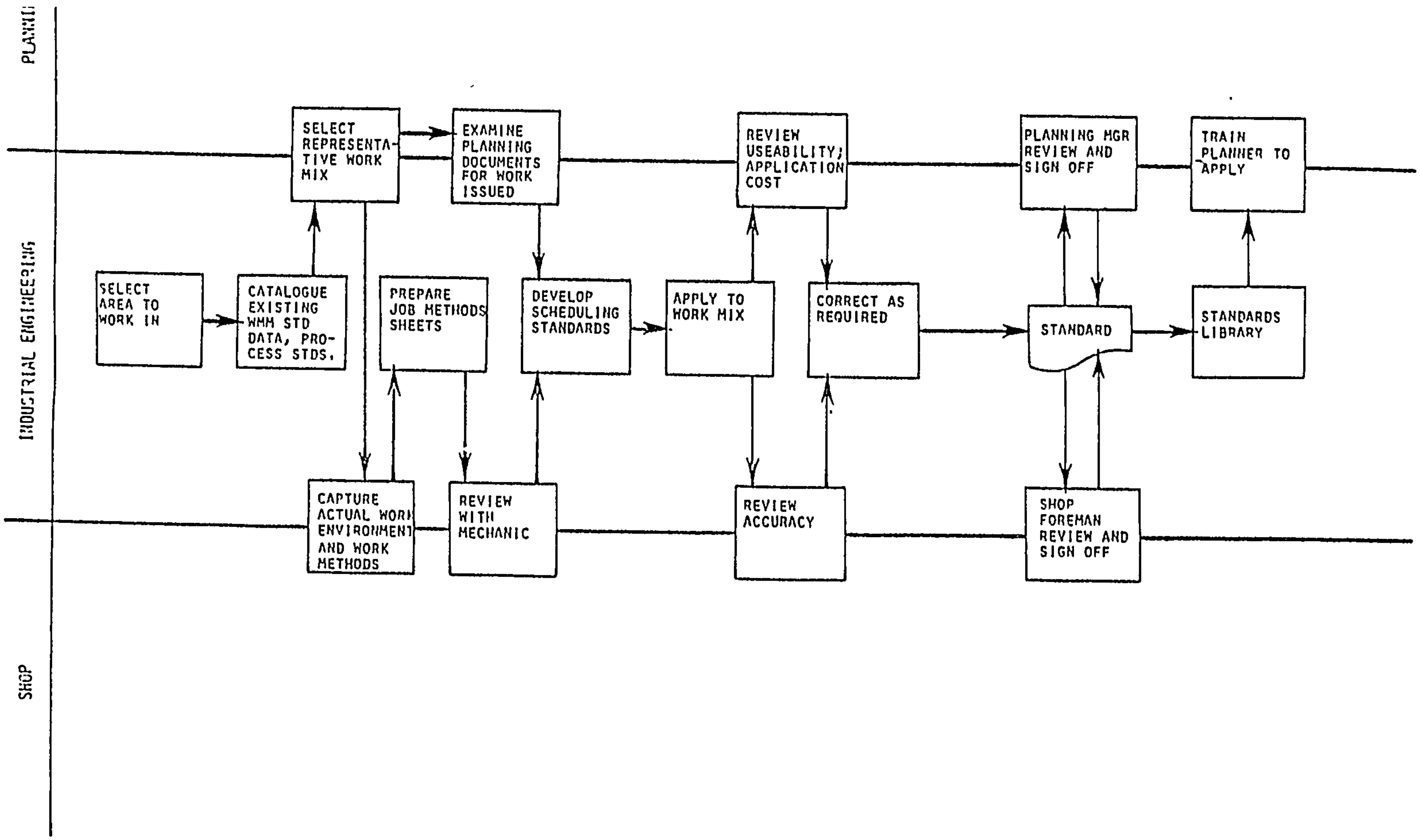

FIGURE 3-18: MAKING A SCHEDULING STANDARD

ed. The first two steps are purely internal organizational actions. The selection of a work area is based on two factors: (1) standard data exists in sufficient quantity; and (2) inputs to that work area (labor, material, and planning information) must be controllable, or at least predictable. This second factor is extremely important, as the best budgets and schedules will be thoroughly disrupted if upstream work stations are not able to support the work area under study.

Once the work area is selected, appropriate Process Standards should be developed and cataloged with the standard data in a workable format. A representative work mix is then chosen for the initial study. Actual work methods and the actual work environment is then captured on a job methods sheet (Figure 3-19). While this is taking place, the planning documents and drawings in normal usage are examined so that design of the format for the Scheduling Standard can be made compatible with the information available to the planner/scheduler at that level.

The Scheduling Standard is then developed through a series of trials and adjustments, combining the variables and characteristics appro-

JOB METHOD SHEET

PAGE 5 of 5

REF JOKO 39-643-51701 KO 127

ANALYZED BY [illegible] DATE 9-21

SHOP 56 SECTION/FOREMAN Mr. Cineo

TIMES ASSIGNED [illegible] DATE 9-22

JOB/OPN STD NO.

WORKSITE 643

JOB STEP

TITLE Steam Distillation Plant - RO Valves

REF		PL 2117750 JOB ELEMENTS 5, 8, 28, & 76	NO. OCC	MIN/ OCC	TOTAL MIN
T&O	1	Travel to PMG Bldg 178 & return	2	10.10	40.40
	2				
T-A3	3	Obtain (3) 1" & (3) 3/4" Red Blanks	6	1.50	18.00
	4				
N-1	5	Select Tools from Tool Box	16	.20	3.20
	6				
F-7	7	Travel to Shop Stores for Bolts, Nuts, Blanks, and Tape	2	5.60	11.20
	8	and Return	2	2.40	4.80
	9				
D-14	10	Travel to Eng. Rm. 643	4	2.45	9.80
	11				
	12	Unbolt (3) Flanges [illegible] By-pass Valve	3	[illegible]	
	28				
	29				
	30				
	31				
		Continued onto next page PAGE TOTAL			310.10

CORPORATE-TECH PLANNING INC.

FIGURE 3-19: JOB METHODS SHEET (TYPICAL)

Results should be reviewed with the shop for accuracy, and with planning for ease of application.

After the library of standards is complete enough to support an area (perhaps 85% coverage), people doing planning and scheduling should be trained in how to use the standards.

As the product mix changes and/or unproductive practices are identified and eliminated, the affected standards must be modified and updated. This action demands that the standards development people have a good working rapport with production people. Otherwise those in production will be loath to identify the areas that truly need to be trimmed and may only suggest looking at those items which they feel are too tight.

C. Use of Parametric Formulae

Development of a Scheduling Standard using parametric formulae follows the same steps as with the use of standard data, except that the formulae involved are based on actual performance data which has been aggregated and adjusted to suit the particular parameters involved in that production function (e.g., pipe diameter, generic material, number of bends, welds, caps, etc.). A limited attempt was made to investigate the use of formula standards in connection with the Scheduling Standards Pilot Project at PBI described below.[4]

[4] A project to further investigate the development and use of formula standards is being planned for execution during 1985 under the Industrial Engineering Panel SP-8 of the Ship Production Committee of SNAME as part of the National Shipbuilding Research Program.

3.6 Scheduling Standards Pilot Project

Development and application of Scheduling Standards using this technique was actually carried out during a pilot project conducted at Peterson Builders, Inc. (PBI), Sturgeon Bay, WI from September 1981 through April 1982. The Summary Report of Scheduling Standards Pilot Project, Reference C, describes the procedures used and the results obtained. In addition, a Scheduling Standards Workshop containing the details of the pilot project was conducted at several locations throughout the country during April and May 1983 (see Chapter 5 of this Primer) . The general approach to the Scheduling Standards Pilot Project included the following steps:

- Obtain MOST data for a selected group of work orders, and determine level (standard) times[5] for doing the work.

- Conduct work sampling to determine process time and non-process time fractions. (Work sampling also provides detailed insight into both categories). Take five minute work observations once each hour for each of three

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5 Two approaches to obtaining level (standard) times were ‘a-ctually tried: (1) fise of basic MOST data; and (2) use of classification data based on MOST data. The latter approach proved to be the most useful.

two-week testing periods. Determine the percentage of time mechanics were carrying out the basic process (called the process time fraction), and the percentage of time the mechanics were engaged in non-process activities (called the non-process fraction).

- Calculate a non-process factor. Basically,

$$\text{Non-process factor} = \frac{\text{non-process time fraction}}{\text{process time fraction}}$$

- Calculate scheduling standard hours (level time increased by the non-process factor).

Schedule Standard Time =
Level Time +(Level time x non-process factor)
or,
Schedule Standard Time =
Level Time (1 + non-process factor)

Illustration of the above, using actual and typical data from the pilot project, is as follows:

From MOST data, determine

Level Time (one work order) = 30.2 hours

From work sampling, determine

Non-Process time fraction = 31.3%

Process Time Fraction = 68.7%

Calculate

$$\text{Non-Process factor} = \frac{31.3\%}{68.7\%} = .456$$

Calculate

Scheduling Standard Time = 30.2 (1+.456) = 44 hours

- Determine the actual costs for the work.
- Analyze data to see whether scheduling standard predictions match actual costs.
- When prediction capability is established, load the shop using scheduling standard hours and see if benefits accrue.

Actual benefits accrued from this pilot project were initially a 50% increase in pipe production with the same number of pipe fabricators. In the eighteen months following completion of the pilot project, PBI adjusted the layout and expanded the amount of work assigned to the pipe fabrication shop, established additional Scheduling Standards and a computer-assisted information system to aid in scheduling the work and balancing the several work centers involved, and subsequently claimed a throughput increase of about 500% with essentially the same number of pipe fabricators. Clearly, the use of Scheduling Standards for shop work center loading and balancing can be a valuable assist in improving ‘the efficiency and reducing the cost of production operations.

CHAPTER 4

AN APPROACH TO PRODUCTION ORIENTED PLANNING

BRIEF

Guidance is provided for the smaller shipyard wishing to initiate a program leading to improved planning, scheduling, and production control, and thereby enable substantial improvement in production performance. The essential steps are described, including sources of the engineered standard data needed to create useful standards. The five examples of smaller shipyards described earlier are used to illustrate how each might initiate a practical program. Other smaller shipyards should be able to relate their own particular circumstances to these illustrations.

AN APPROACH TO PRODUCTION ORIENTED PLANNING

4.0 Prologue

The use of engineered labor standards within a shipyard offers the promise of greatly improved planning and scheduling, leading to substantial improvements in production control and ultimately to large reductions in labor costs for productive work. The use of Scheduling Standards for these purposes has been demonstrated, and has produced major savings in cost and time. Most smaller shipyards have no in-house industrial engineering capability and~ indeed, may not enjoy formal planning, scheduling, and production control as described in this Primer and in reference A. While a small shipyard cannot commit large amounts of overhead money to extensive programs which may not produce a payback for many months, much CAN be done to improve productive efficiency with a modest investment of time and talent over a relatively short period. From this beginning, a small shipyard should be able to boot-strap their operations to more productive heights, building on the smaller advances and savings produced initially.

From the research results gained to date, it appears that the development and use of Scheduling Standards for planning, scheduling, and work center loading/balancing is a good starting point. The standards needed can be relatively crude compared to those necessary for more sophisticated methods engineering, for instance, while still serving as excellent tools for improving productive performance. Later on, if a shipyard so desires, the more detailed and precise aspects of industrial engineering can be pursued in any particular area which needs it, based on the visibility of the productive process gained through use of Scheduling Standards.

With this prologue in mind, consider the steps necessary to create a standards program in a small shipyard.

4.1 Assign People

The initial investment in people is small, with only one or two people needed to set up the program and begin development of Scheduling Standards. These people should have an engineering background, but not necessarily industrial engineering (although that would be most helpful). They must, however, enjoy a good relationship with the production people among whom they will be working closely and constantly for several months. This relationship must be open and constructive, or else the vital input from production may not be realized. In the other direction, these people should report to a reasonably high level shipyard manager who will encourage and support the program and ensure that they are ALLOWED to conduct their business with a minimum amount of interference. Support from top management is as essential to success as is support from production people. It is important to establish and maintain a no-threat atmosphere throughout the program.

4.2 Train People

The assigned people should receive training in the fundamentals of industrial engineering techniques (see Chapter 5). These techniques include the development of engineered standard data, work sampling and measurement, work center loading and balancing, formulation of scheduling standards, shop capacity determinations, and general scheduling procedures. A person with an engineering background, and who is already familiar with shipyard production operations, should encounter little difficulty in learning these techniques and applying them to shipyard situations on the small scale envisaged for initial involvement. The assigned people should learn about recent related accomplishments (such as the 1982 Scheduling Standards Pilot Project at PBI) so that the present state-of-the-art in shipyards is understood. The overall intentions of the program, its goals and guideposts, should be kept in constant focus, along with the ultimate possibilities of these techniques for improving shipyard productivity. This will help to maintain their enthusiasm and keep the program properly directed, while guarding against discouragements and distractions. About three to four weeks total time should be sufficient for this initial training (not necessarily continuous).

4.3 Select Initial Area

Once the people are assigned and trained, an area should be selected for initial setup and prosecution of the program. The initial area should be small geographically, functionally, and in workforce. It should be a manageable area as free from outside (upstream) influences as possible to avoid (or at least minimize) frustrating complications external to the program itself. Once the program is in place and functioning, these inevitable external influences can be handled with surprising ease, but initially they should simply be avoided whenever possible. A small pipe shop, sheet metal shop, machine shop, or similar area (or portion thereof) would make a good starting point. . An area where engineered standard data is already available or c-an be obtained relatively easily would be an ideal initial location.

4.4 Involve Production People

Clearly, the program cannot succeed without the involvement and support of the production people themselves. They are a vital part of the program and must be treated as such. They should be kept informed of program intentions and progress on a regular basis, so that everyone contributing to the program can maintain a current knowledge of events that may affect them - whether directly or indirectly. It is common nature to assume that others share a detailed knowledge about what is going on, but unfortunately this is not always the case. Islands of doubt and confusion will grow rapidly unless they are prevented through regular and deliberate communications. When everyone involved is consistently oriented and informed, then the team effort sought will grow and produce. The cooperation and support of ALL contributors to the program, especially the production people, is absolutely essential to success.

4.5 Develop/Obtain Engineered Standard Data

This step in the setup process is perhaps the biggest unknown. Both process and non-process data is needed, with the latter being relatively easy to obtain through work sampling techniques (see Reference C). The process data can be developed in several ways, and is sometimes usable from the published literature. Sources of engineered standard data are discussed below.

a. Maynard Operational Sequence Technique (MOST)

The need for uniformity in standard data development was recognized at the outset of research efforts by SP-8. For this reason, the Maynard Operational Sequence Technique (MOST) was selected by the six shipyards initially involved in the Ship Producibility Research Program under SP-8. Personnel in several shipyards have been trained[6] to use this predetermined motion time system by H. B. Maynard and Company. By capturing the work method through direct observations, and integrating the observed method with the work place geometry (move distances), the standard time for any manual operation is determined. When combined with machine times (e.g. , arc times) and appropriate standard allowances, the standard time to accomplish a particular job can be calculated. MOST readily lends itself to methods engineering. Alternative methods can be synthesized by a shipyard technician without having to disrupt the actual work flow. Once a methods change has been developed, it can be systematically and efficiently implemented. MOST data has been developed by several participating shipyards in the general areas shown in Figure 4-1. The data for each development area is contained in a Work Management Manual[7] produced by the developing shipyard. The Work Management Manual arrangement provides a standard format for relevant data, as shown by Figure 4-2. The" MOST system is briefly described in Reference D, Standard Data Application Guide,

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6 MOST training ' is available from the Maynard Management Institute, Charlotte Plaza, Suite 1590, 201 s. College Street, Charlotte, SC 28244, Telephone (704)376-3584 (Carl E. Robertson, Vice President) .

7 The Work Management Manuals produced by the shipyards participating in the Ship Producibility Research Program can be obtained from the MarAd Program Office of the Bath Iron Works Corporation, 700 Washington Street, Bath, Maine 04530, or from Mr. Guy Gattis, Research Information and Publications Service, 2901 Baxter Road, Ann Arbor, Michigan 48109.

which also contains the logic and principles of the development and use of engineered labor standard data.

AREA	BAY	BIW	BSP	NNS	NSS	PBI	HIM
ASSEMBLY		X			X		
BLAST/COAT				X		W	X
ELECTRICAL						X	
ERECTION	X						
FIT/WELD		W					
FAB/ASSY COMPONENTS		X			X		
PANEL LINE					X		
PIPE SHOP					W	X	
SHEET METAL					W		
STAGING			X				
JANITORIAL SERVICES					X		
MAXI-MOST				X			

SHIPYARD

X DEVELOPED
W WORKING
(1983)

FIGURE 4-1: MOST DATA DEVELOPMENT AREAS

b. Computer MOST

MOST Computer Systems* is an interactive on-line software program designed to assist managers in making the best use of resources at

8 More information on MOST Computer Systems and available training can be obtained from Maynard Management Institute, Charlotte Plaza, Suite 1590, 201 s. College Street, Charlotte, SC 28244, Telephone (704)376-3584. (Carl E. Robertson, Vice President) .

WORK
MANAGEMENT
MANUAL

Company:

Bath Iron Works Corporation
700 Washington Street
Bath, ME 04530

Ref. Code: For information pertaining to the shipyard in general, see Bath Iron Works Corporation's General Work Management Manual.

Department:

Dept. 34 (Fitting)
Dept. 36 (Welding)

Work Center/Group:

Hardings Plant C Bay
Steel Small Assembly (West End)
Aluminum Small Assembly (East End)

Date: May 1, 1980

Prepared by:
Dept. 56 Industrial Engineering
FDG/MWC/ECC

Approved by:

R. J. Bellonzi, Mgr. Mfg. Eng.
D. Williams Consultant EBM Co.

Copy No. of

Assigned to:

Developed for MARAD Task ES-8-2
Under the Direction of E. B. Maynard and Co., New York, New York

WORK CONDITIONS

1. SCOPE
2. STANDARD PRACTICES & PO[illegible]S
3. FACILITIES & EQUIPMENT
4. LAYOUTS & MATERIAL FLOW
5. PROCESS DATA
6. MANUAL METHODS

STANDARDS

7. STANDARD TIME CALCU[illegible]

DATA SUPPORT

8. DATA SYNTHESIS & BACK-UP
9. ALLOWANCES

DATA USE

10 STANDARDS APPLICATION

FIGURE 4-2: TYPICAL WORK MANAGEMENT MANUAL TITLE PAGE their disposal. Several shipyards participating in the generation and use of MOST standard data under the Ship Producibility Research Program have entered their developed data into Computer MOST for their own ready retrieval and use as well as for sharing among other participating shipyards at the sub-operation data level. Computer MOST makes use of the Maynard Computer Center at Pittsburgh via telephone-connected terminals on a lease arrangement. Computer MOST offers to a participating shipyard computer-assisted standards development using MOST sub-operation data~ and to ensure security of proprietary information the standards thus produced can be altered or retrieved only by the shipyard that developed them. All of the sub-operation data in the data bank, however, including those data entered by other shipyards, is intended for sharing among the participating shipyards.

C. Classification MOST

During the Scheduling Standards Pilot Project (Reference C) the development of Scheduling Standards directly from detailed MOST data was found to be somewhat tedious and time consuming. In order to facilitate use of detailed MOST data, the concept of Classification MOST, Reference E was developed to permit easier and more rapid use of valid standard data toward generation of Scheduling Standards. Classification MOST produced charts, such as Figures 4-3 and 4–4, from

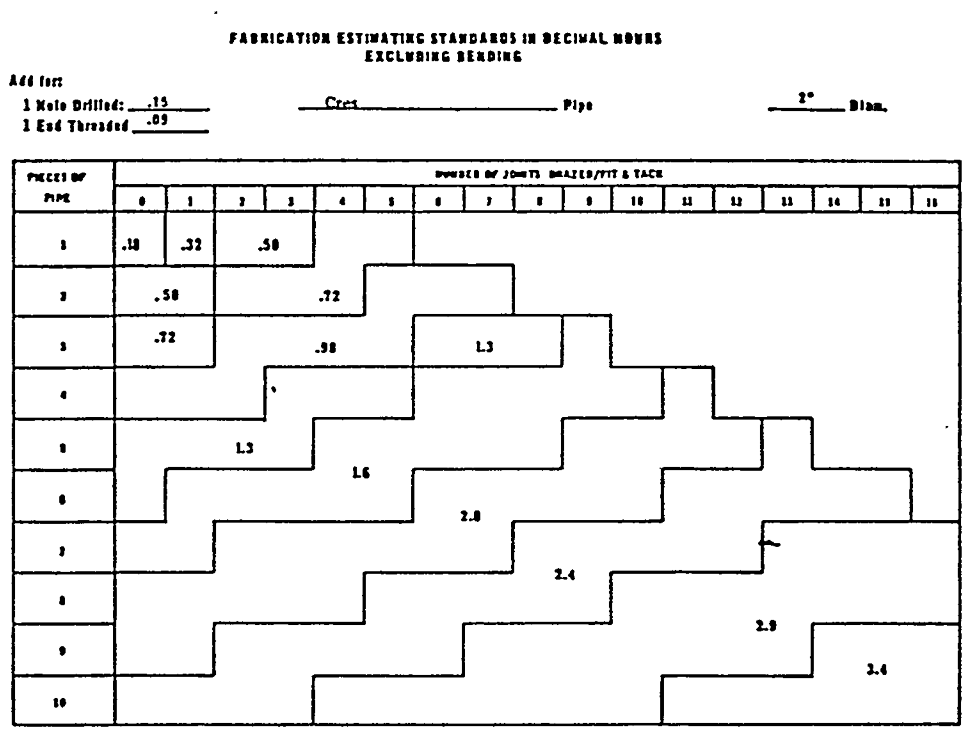

FIGURE 4-3: TYPICAL CLASSIFICATION CHART - PIPE FABRICATION

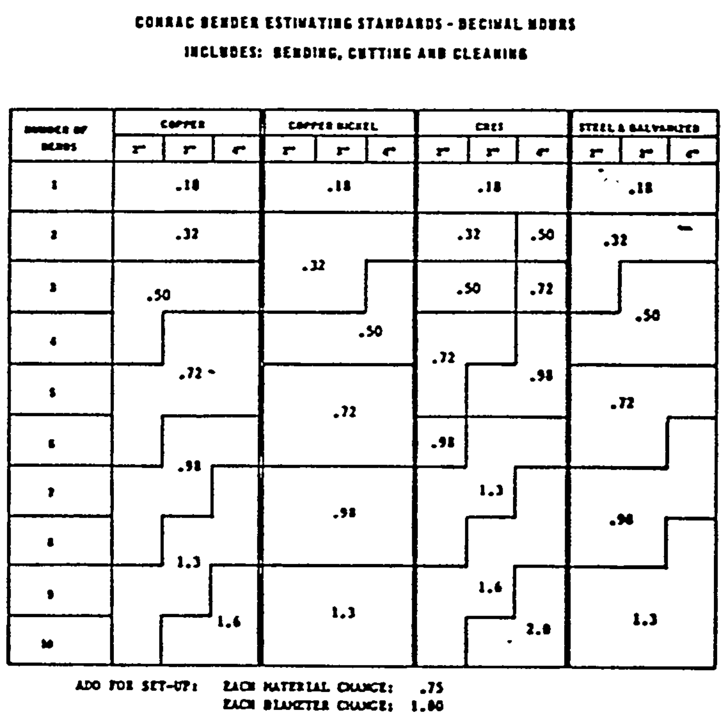

FIGURE 4-4: TYPICAL CLASSIFICATION CHART - PIPE BENDING

which standard ,times are readily retrievable. Scheduling Standards developed from Classification MOST were compared with those developed directly from detailed MOST for the same identical work orders, and were found to yield essentially the same time predictions for accomplishing that work. Thereafter during the pilot project, Classification MOST only was used for the development of Scheduling Standards.

A labor standard classification system, such as Classification MOST, offers a practical solution to the problem of capturing, sorting, aggregating, and retrieving standard data, at least for use in developing Scheduling Standards, Planning Standards, and Cost Estimating Standards which do not require precisely accurate standard data[9]. For detailed methods engineering or support for incentive pay scales, for example, the more accurate basic standard data (such as MOST) may be required.

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9 Transfer of engineered standard data from a developing shipyard to a different user shipyard will be explored during a project under the Ship Producibility Research Program during 1985. Since Classification MOST has been quite satisfactory for developing Scheduling Standards, this method of data transfer will be among those examined for use as the transfer vehicle among shipyard users interested in applying existing standard data at the Scheduling Standard level for scheduling and shop work center loading.

d. Formulas Developed from Performance Data

Formulas can be developed which use the basic parameters of the production work under consideration (e.g., Pipe material, diameter, schedule, number of bends, welds, mechanical joints, caps, etc.) together with statistically derived process times for the fabrication events involved, which add in the non-process time increment necessary to fit the standard to the real world conditions at the workplace, and which will then yield a reliable prediction of the time that it will take to do the work. During the Scheduling" Standards Pilot Project (Reference C) a concurrent project was conducted to test the development of "Scheduling Standards using production performance data. This limited investigation into parametric formulae for developing Scheduling Standards produced promising results. Parametric formulae, like labor standard classification systems, can provide practical support to the development of Scheduling (and higher) Standards[10].

J-u The development and use of parametric formulae in support of scheduling and shop work center loading will be investigated during a project under the Ship Producibility Research Program during 1985.

e. Work-Factor System (Wofac)

A standard data development system somewhat similar to MOST is the Work-Factor System (Wofac) developed by Science Management Corporation[11]. Wofac uses Work-Factor Time to represent worker performance pace, rather than the "normal" or "average" time usually associated with other systems (like MOST). Using the Work-Factor System, time standards are established through examination and analysis of each Manual Motion and Mental Process required to perform useful work. Since Work-Factor Time represents the output attainment capability of average experienced operators, working with good skill and good effort and without interruptions or delays, it is the common denominator and index of output capability (expected attainment) for the world population of average experienced operators. As such it is promoted by SMC as a universal standard, to which allowances for operator personal time and unavoidable delays are applied separately to compute allowed or standard time.

J-I. More information on the Work-Factor System can be obtained from SMC Wofac, . Science Management Corporation, P. O. Box 6800, Bridgewater, N. J. 08807. Telephone (201)685-9000. (James McGurk).

f. MTM

MTM (Methods-Time Measurement)[12] is composed of operational analysis techniques which have been objectively developed through the establishment of clearly defined actions for performing physical work, and accompanied by the corresponding time intervals within which a person can reasonably be expected to perform that work. The MTM Association for Standards and Research is an international organization which has as its major purpose the implementation and expansion of these concepts. The Association is collectively owned by its membership as a non-profit entity serving the business community at large. It offers MTM packages and programs, computer-aided applications, special purpose data systems, training, applicator and instructor certification, publications, seminars and conferences.

The family of data systems offered by the Association consists of the following:

1/? MTM was the forerunner of MOST. Dr. H. B. Maynard was one of the founders of the MTM Association.

13 More information can be obtained from MTM Association for Standards and Research, 9-10 Saddle River Road, Fair Lawn, New Jersey 07410. Telephone (201)791-7720 (James P. O'Brien, Executive Director).

- MTM-1. This is the original detailed system upon which all MTM Systems were developed. This intricate, thorough system meets high standards on methods description and precision in time determination~ and contains time values as low as .07 second if required by a specific application.

* MTM-2. This system was constructed ' by building motion combinations using the basic motions of the MTM-1 System. It has a more limited number of distance ranges and cases of control than MTM-1, resulting in faster decision making. It achieves a higher speed of analysis - approximately twice that of MTM-1. Conversely, there is a lower degree of method description and less precise time determination for comparable work cycles. Nevertheless, at work cycles of one minute or more, the precision of MTM-2 is still within ± 5% of MTM-1 in 95 out of 100 cases.

- MTM-3. This system was derived from MTM-1 through a further simplification and combination of the basic motions and their variables. It has a higher speed of analysis (approximately seven times that of MTM-1) for those situations where less detailed method description and reduced precision in time prediction can be allowed. However, when analyzing comparable work cycles of 4 minutes or more, MTM-3 precision will still be within + 5% of MTM-1 in 95 out of 100 cases.

9. MEK / UAS[14]

MEK and UAS are two systems developed by the German MTM Association to augment MTM-1 for measuring one-of-a-kind and small batch production which may prove to. be attractive for shipyard applications. The systems have as their independent variables not the motion sequence of the work, but the physical conditions in which the motion sequence takes place. The analysis does not determine the time-span sequence of "gets" and "places", etc. as would be done with MTM-1. Instead, the analyst determines that "gets" and "places" do occur, the accuracy of the "places", the distance the objects must be moved, and the weight and bulk of the object. MEK is the basic system. UAS is a somewhat more complex system than MEK because it is designed for higher level operations. For example, MEK has four divisions in the "get and put" category, whereas UAS has thirteen divisions. However, UAS has the same basic composition and features as does MEK.

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14 MEK = MTM FUR EINZEL UND KLEINSERIENFERTIGUNG

UAS = UNIVERSELLES ANALYSIER SYSTEMS

h. Published Literature

There are extensive quantities of engineered standard data available in published form. The principal difficulty in using them is in adapting these data to a particular work situation in a shipyard. .While machine times may be transferable from a similar machine in another shipyard with minimal modifications, labor times are strongly dependent on workplace geometry and working conditions, and therefore may be more difficult to qualify as usable for a particular job. Use of standard data from published sources depends on a careful understanding of the precise conditions under which these data were developed and can be applied, along with an equally precise understanding of the conditions existing in the using shipyard. Both pieces of information can be elusive, which may support independent generation of detailed data at the using workplace as the more practical solution. If published data DOES fit, however, its use clearly will be economically preferable.

i. Independent Development

There are a variety of industrial engineering consulting organizations available to a shipyard that can provide engineered labor standards which define production performance. A small shipyard wishing to acquire engineered labor standards on a small scale in a well defined, limited production area may find this alternative attractive. These engineered labor standards, however, will probably require the addition of “non-process factors” in order to accommodate the real-world conditions (see Reference C) found in a shipyard before they are practically usable for scheduling and shop work center loading.

This word of caution is added here to emphasize, once again, that performance to the pure “standard” in the industrial engineering sense is likely only in high volume, highly repetitive operations, and that these operations are RARELY found in a shipyard. Industrial engineering principles were originally developed for comparatively controlled environments, and their adaptation to shipyard work is not an exact science. Sound management judgement must temper the natural desire for more and more accuracy, which is both expensive and -unnecessary especially in the early stages when large benefits can be realized through application of mid-level Scheduling Standards of modest accuracy. Once a shipyard has gained a foothold in applying engineered labor standards, the most beneficial application and its associated accuracy requirement can be pursued for best economy within the existing, successful framework. This additional standards development and fine tuning will probably be best performed in-house, regardless of the source of the initial standards.

h. Combinations of the Above

Whatever the needs of a shipyard for engineered labor standards, use of any or all of the above alternatives for gaining standard data should be considered. Initially, examination of the existing bank of standard data developed under the Ship Producibility Research Program should be made to see whether the transfer of applicable data might be worthwhile". These data were developed with the premeditated intention of shared usage, and hopefully this objective will be realized. Classification schemes and/or parametric formulae may facilitate the transferability of standard data to the benefit of the smaller shipyards wishing to avoid the expense of separate development.

Whatever the initial source of standard data, other avenues can be explored as a shipyard grows in understanding and ability to apply engineered labor standards to meet local needs. It is NOT necessary to stay with the initial source of standard data to the exclusion of all others, since standard data from whatever source should, by definition, be equally valid.

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15 This Program is administered by the Ship Producibility Research Program Managerl Bath Iron Works Corporation, 700 Washington Street, Bath, Maine 04530. Telephone (207)433-3311.

4.6 Establish Baseline Data

The real need is for true and undistorted initial performance data for use as a baseline against which to measure improvements. Most shipyards have some type of management information system that reports production expenditures by work increment (work order, work package, ship system, etc.). Larger shipyards often have extensive computer-based management information systems that can provide nearly any desired sort and array of data in the system. As noted earlier, however, when labor expenditures are based on time card entries, inaccuracies can distort and amplify the true picture on an individual work increment by major proportions. This problem is encountered even with the sophisticated labor collection systems used in larger shipyards, and is no less of a problem in the smaller shipyards with little or no computer assistance for data processing.

Work sampling and measurement techniques can be used to develop data for comparison with time card entries, revealing the size of the problem. Although this comparison may not generate a truly accurate baseline, at least the inaccuracy of the baseline data will be assessed. The available data can then serve as a legitimate starting reference for measuring improvements. Once a standards program is in place and serving as an independent reference, a better baseline will quickly result.

4.7 Adjust Loading

Shop work center loading should be adjusted using Scheduling Standards to determine the appropriate workload and the workforce needed to accomplish it. Initially, a work center should be loaded to between 100% and 110% of capacity according to the Scheduling Standards. Workload and workforce should be BALANCED so that workers are neither overloaded nor underloaded. When underloaded, workers will slow down so that they do not run out of work, resulting in lower performance. When overloaded, workers will see an unrealistic demand, and will slow down to a comfortable pace. When workload and workforce are properly balanced, workers will see a realistic and credible load and will work at their best pace, resulting in their best performance.

Experience will later determine the best total loading for each work center as well as the true capacity of the production area covered by the standards program. As productive performance improves, the non-process factor in the Scheduling Standards can be decreased due to less time loss on non-process activities. When this factor eventually stabilizes (after perhaps several months of gradual decrease), the true capacity of the area will be known. Thereafter, work can be loaded to suit overall needs, while assigning workers so as to maintain a good balance between workload and workforce.

4.8 Measure Results

Productive performance should be measured using the same yardstick as was used to determine baseline performance. Areas of improvement will become apparent, as will areas where problems exist and require resolution. The visibility of the productive process gained through use of the standards program will reveal situations that may have been totally unanticipated. These conditions can be brought into careful focus and treated methodically until productivity reaches a practical maximum.

A word of caution concerning the natural thrust for continued improvement may be in order at this point. Once REASONABLE improvements are realized in the initial area, it will probably not pay to continue striving for every possible improvement in that area. On the contrary, it will undoubtedly be more beneficial, from the total shipyard point of view, to move to ANOTHER shop or area and produce similar basic improvements there. Initial gains from the application of Scheduling Standards will be surprisingly large, and it will be more advantageous overall to enjoy these gains across the whole productive process than to squeeze every bit of improvement out of any single area. After the entire shipyard has been treated once, experience clearly will direct which areas should be refined further.

4.9 Shipyard Approach - Five Examples

Five examples of small shipyards were given in Chapter 1. A suggested approach to initial introduction of Scheduling Standards is discussed below for each of these five examples. These suggestions are based on the organizational and functional arrangements existing in each shipyard, a general understanding of the productive work commonly encountered, and the shop/facility arrangements presently in use.

a. Shipyard Example No. 1 (Figure l-l)

- Manager in Charge: SUPERINTENDENT ENGINEERING
- Project Leader: One person, under SUPERINTENDENT ENGINEERING
- Initial Area: "Anytrade" Fabrication shop area used by any trade, or a portion of it
- Scheduling Standards Application: By SUPERINTENDENT PRODUCTION MANAGER (or assistant)

b. Shipyard Example No. 2 (Figure 1-2)

- Manager in Charge: DESIGN/PLANNING
- Project Leader: One person, under DESIGN/PLANNING
- Initial Area: Fabrication Shop
- Scheduling Standards Application: By PRODUCTION MANAGER (or assistant) , or by the Shop Head with assistance from the Project Leader.

c. Shipyard Example No. 3 (Figure 1-3)

- Manager in Charge: Operations/Planning
- Project Leader: One person, under Operations/Planning, with one assistant
- Initial Area: Fabrication Shop
- Scheduling Standards Application: By Operations/Planning Project Coordinators, or by the Shop Head with assistance from the Project Leader.

d. Shipyard Example No. 4 (Figure 1-4)

- Manager in Charge: PRODUCTION CONTROL MANAGER
- Project Leader: One person, under PRODUCTION CONTROL MANAGER
- Initial Area: Machine Shop
- Scheduling Standards Application: By PRODUCTION CONTROL MANAGER (or assistant) , or by the Shop Head with assistance from the Project Leader.

e. Shipyard Example No. 5 (Figure 1-5)

- Manager in Charge: MANAGER PLANNING/ESTIMATING
- Project Leader: One person, under MANAGER PLANNING/ESTIMATING, with one assistant
- Initial Area: Welding
- Scheduling Standards Application: By Planners.

f. Program Expansion

The initial approaches suggested above would serve to introduce Scheduling Standards into each shipyard for scheduling and shop work center loading purposes. As experience with the program is gained, expansion into other areas and to other levels of standards can proceed at whatever pace the shipyard may desire.

As the volume of program activities increases, it may be necessary to add people to the Project and even to establish a separate organizational group to handle the program. If this is done, however, care must be taken to preserve the present working relationships among shipyard managers and groups. As noted in Chapter 1,” the organizational and functional arrangement in each small shipyard reflects the particular assemblage of people and talent who make up that shipyard. It follows that these working arrangements ARE the shipyard, and that success depends on them. A standards program should be infused into a small shipyard so as to assist and support present capabilities, not upset or replace them. Expansion should be viewed in this light, and should proceed at a pace that can be accommodated both financially and managerially. With so many advantages in the offing from a standards program, that pace may prove to be faster than first anticipated.

There is a message here for planning and production control specialists that may emerge as the program grows, and who are eager to extend and reinforce their newly acquired control. It is to keep a careful focus on the user. Otherwise, the refinement and extension of control that they impose may suffocate the production workforce and greatly impair shipyard performance. There is a heavy and continuing responsibility encumbent on every member of the team to keep the interests of the whole shipyard in view, and to see that an efficient, effective operation is maintained. This responsibility is heaviest for those who can affect the actions of others and shape the posture of the shipyard in the process.

CHAPTER 5

SOURCES OF MORE INFORMATION

BRIEF

Several sources of information related to the subject matter of this Primer are listed and discussed. Although improved planning and production control through a program of engineered labor standards is the principal thrust of this Primer, this effort is recognized as only one of many being pursued under MarAd and Navy research. A good standards program, however, will illuminate the real facets of production performance that otherwise may remain obscured. Such improved visibility can be helpful in implementing other techniques for improving shipyard performance such as those being pursued by other Panels of the SNAME Ship Production Committee. Included, therefore, is a listing of all Panels, their areas of concern, and a contact point on each.

SOURCES OF MORE INFORMATION

5.0 Academic Assistance

There are growing numbers of activities aimed at providing assistance to the shipbuilding industry toward productivity improvements. Much has already become available under the National Shipbuilding Research Program, and more is under development.

This Primer is concerned with the area of planning and production control in the smaller shipyards, and what follows is a compilation of relevant items already available[16] or expected to develop in the near future. As additional items become available or are identified as active projects, they will be added to this Chapter in future editions of this Primer.

In addition, this Chapter contains a listing of the other Panels of the SNAME Ship Production Committee, a brief description of the area and functions handled by each Panel, and contact points for obtaining more information on each Panel.

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16 Items available from SP-8 may be obtained by contacting:

Ship Producibility Research Program Manager
Bath Iron Works Corporation
700 Washington Street
Bath, Maine 04530
Telephone (207)443-3311

or: Mr. Guy Gattis
Research Information and Publications Service
University of Michigan
2901 Baxter Road
Ann Arbor, Michigan 48T09

5.1 Manuals, Reports, Textbooks

a. Improved Planning and Production Control
(Reference B in this Primer).

AUTHOR : Bath Iron Works Corporation

DATE : August 1977

ABSTRACT: This project was the forerunner of the present I.E. program. It introduced the U.S. shipyards to engineered labor standards and demonstrated the application of these standards for improved planning and production control. Recommendations resulting from this study guided the early works of Panel SP-8.

REMARKS : Out of print. Limited copies available.

b. A Manual on Planning and Production Control for Shipyard Use
(Reference A in this Primer)

AUTHOR: Corporate-Tech Planning, Inc.

DATE : September 1978

ABSTRACT: A “how to” manual for the development and application of engineered labor standards for improved planning and for production control. This publication is intended for middle- level managers and supervisors in large and medium size shipyards.

REMARKS : Copies available from SP-8.

c. <u>Standard Data Application Guide</u>
(Reference D in this Primer)
AUTHOR : Bath Iron Works Corporation
DATE : June 1981
ABSTRACT: The basic logic and principles of the development and use of engineered labor standard data is presented. The Maynard Operation Sequence Technique (MOST) system is described. A brief glossary of industrial engineering terminology is also included.
REMARKS : Copies available from SP-8.

d. <u>Labor Standards Classification System</u>
(Reference E in this Primer)
AUTHOR : H. B. Maynard and Co.
DATE : January 1982
ABSTRACT: This reports on the development, testing, and method for rapid application of an improved system for using engineered labor standards in estimating and manpower scheduling. Charts of estimating standards for a Conrac Pipe Bender, Greenlee Pipe Bender, and for mechanical pipe fitting are included.
REMARKS : Copies available from SP-8.

e. Scheduling. Standards Pilot Project, Summary -

(Reference C in this Primer)

AUTHOR : Corporate-Tech Planning, Inc.

DATE : May 1982

ABSTRACT : This project tested the application of scheduling standards in a pipe fabrication shop. The three testing periods resulted in a documented 50% reduction in man-hours by shop loading with the use of computer generated engineered labor standards.

REMARKS : Copies available from SP-8.

f. Industrial Engineering Applications in the Us. Shipbuilding Industry, 1982 Symposium Proceedings

AUTHOR : Bath Iron Works Corporation

DATE : May 1982

ABSTRACT: Eight papers presented at a 1982 symposium concerning: the work of Panel SP-8; the National Shipbuilding Industrial Base; Scheduling Standards; applications of labor standards; and Flexible Automation. This represents a good crosssection of panel work underway at the time of the symposium.

REMARKS : Copies available from SP-8.

5.2 Workshops, Training

a. Course Material - Methods Engineering Workshop for the Shipbuilding Industry

AUTHOR : American Institute of Industrial Engineers

DATE : November 1981

ABSTRACT: Instructor's Guide Sheet, Student Manual, and color slide sets developed for use in establishing Methods Engineering training sessions within U.S. shipyards.

REMARKS : Limited copies available; slide sets may be borrowed from SP-8.

b. Scheduling Standard Workshop

AUTHOR : Corporate-Tech Planning, Inc.

DATE : January 1983

ABSTRACT: One-day detailed discussion of the Scheduling Standards Pilot Project conducted at Peterson Builders, Inc. pipe fabrication shop.

REMARKS : Six Workshops conducted throughout the U.S. during 1983. Slide set may be borrowed from SP-8. Additional Workshops can be arranged.

c. Video Tapes on Industrial Engineering Topics

AUTHOR : To be determined competitively

DATE : Expected by early 1985

ABSTRACT: Several topics to be covered in priority order. Tape(s) on each topic will be accompanied by printed supporting material.

REMARKS : Currently under development. Shipyard community placing topics in priority order by consensus vote. Development of material for first topic should begin by Spring 1984.

5.3 MOST Work Management Manuals

a. MOST Work Management Manual - General Operations

AUTHOR : National Steel and Shipbuilding Company

DATE : May 1980

ABSTRACT: A general manual covering standard practices and policies, facilities and equipment, layout and material flow, and production methods at National Steel and Shipbuilding Co. A glossary of terms is included.

REMARKS : Limited copies available from SP-8.

b. MOST Work Management Manual - Panel Line

AUTHOR : NATIONAL Steel and Shipbuilding Company

DATE : May 1980

ABSTRACT: A detailed manual of practices, facilities, material flow and production methods in the NASSCO Panel Line for fitting and welding of plates and flat panel assemblies. MOST calculations included.

REMARKs : Limited copies available from SP-8.

c. MOST Work Management Manual - Steel/Aluminum Small Assembly-I

AUTHOR : Bath Iron Works Corporation

DATE : May 1980

ABSTRACT: A detailed manual of practices, facilities, material flow and production methods in the Bath Iron Works Hardings Plant “C-Bay” for fitting and welding in the steel small assembly and aluminum small assembly areas. MOST system calculations included.

REMARKS : Limited copies available from SP-8.

d. MOST Work Management Manual - Steel/Aluminum Small Assembly-II

AUTHOR : Bath Iron Works Corporation

DATE : July 1980

ABSTRACT: A detailed manual of practices, facilities, material flow and production methods in the Bath Iron Works Hardings Plant “B-Bay” for fitting and welding in the steel small assembly and aluminum small assembly areas. MOST system calculations included.

REMARKS : Limited copies available from SP-8.

e. MOST Work Management Manual - General Operations

AUTHOR : Bay Shipbuilding Corporation

DATE : August 1980

ABSTRACT: A general manual of practices, facilities, material flow and production methods at Bay Shipbuilding Corp. A glossary of terms is included.

REMARKS : Limited copies available from SP-8.

f. <u>MOST Work Management Manual - Panel Assembly in Platen Area</u>

AUTHOR : National Steel and Shipbuilding Company

DATE : September 1980

ABSTRACT: A detailed manual of practices, facilities, material flow and production methods in the NASSCO platen area for layout, burning, fitting, welding and grinding of panel assemblies. MOST calculations included.

REMARKS : Limited copies available from SP-8.

9" <u>MOST Work Management Manual - Hull Erection</u>

AUTHOR : Bay Shipbuilding Corporation

DATE : January 1981

ABSTRACT: A detailed manual of practices, facilities, material flow and production methods in the Bay Shipbuilding graving dock and platen area for super-section assembly and hull erection and regulation. MOST calculations included.

REMARKS : Limited copies available from SP-8.

h. <u>MOST Work Management Manual - Pipe Fabrication Shop</u>

AUTHOR : Peterson Builders, Inc.
DATE : January 1981
ABSTRACT: A detailed manual of practices, facilities, material flow and production methods in the PBI pipe fabrication shop for cutting, end preparation, bending, fit-up, welding and brazing of pipe. MOST calculations included.
REMARKS : Limited copies available from SP-8.

i. <u>MOST Work Management Manual - Blast and Coat on Platen and Drydock</u>

AUTHOR : Newport News Shipbuilding
DATE : March 1982
ABSTRACT: A detailed manual of practices, facilities, material flow and production methods in the Newport News North Yard Platen and #12 Drydock for grit blasting and spray painting of a commercial vessel. MOST calculations included.
REMARKS : Limited copies available from SP-8.

MOST Work Management Manual - Main Assembly

AUTHOR : Bath Iron Works Corporation

DATE : March 1982

ABSTRACT: A detailed manual of practices, facilities, material flow and production methods in the Bath Iron Works Main Assembly Building for fitting and welding of plates and flat panels. MOST calculations included.

REMARKS : Limited copies available from SP-8.

k. MOST Work Management Manual - Plate Shop

AUTHOR : National Steel and Shipbuilding Company

DATE : March 1982

ABSTRACT: A detailed manual of practices, facilities, material flow and production methods in the NASSCO Plate Shop for the cutting and construction of small subassemblies. MOST calculations are included for foundations, brackets, and ladders.

REMARKS : Limited copies available from SP-8.

l. MOST Work Management Manual - Electrical Work for Shipboard Installation

AUTHOR : Peterson Builders, Inc.

DATE : April 1982

ABSTRACT: A detailed manual of practices, facilities, material flow and production methods in the Peterson Builders Electric Shop, Fabrication Buildings and aboard ship for preparation and installation of electrical components, wires, and cables. MOST calculations included.

REMARKS : Limited copies available from SP-8.

m. MOST Work Management Manual - Temporary Staging for Ground Assembly and Aboard Ship

AUTHOR : Bethlehem Steel Corporation/ Sparrows Point Yard

DATE : April 1982

ABSTRACT: A detailed manual of practices, facilities, material flow and production methods in the Sparrows Point ground assembly area and aboard ship for erection and removal of temporary staging. MOST calculations included.

REMARKS : Limited copies available from SP-8.

5.4 Panels of the SNAME Ship Production Committee

Panel SP-l\3, Facilities/Environmental Effects

The objective of this program is to assist U.S. shipyards in reducing manhours and construction time through the development and implementation of efficient equipment and facilities and improved work flow arrangements. The program addresses all phases of ship construction, including fabrication, assembly erection, outfitting and required shipyard services. The program also includes Environmental Effects (Panel SP-3) considerations involved in facility expansions, and modifications, operations and ship production.

Chairman: Richard A. Price of Avondale Shipyards, Inc.
(504) 436-2121

Panel SP-2, Outfit and Production Aids

The objective of this program is to improve productivity through the development and implementation of improved techniques, methods, and equipment. This program has concentrated on the outfitting phase of ship construction and isnow expanding into other areas such as design modeling, detailed planning, and improved contract negotiations.

Chairman: Louis D. Chirillo of L. D. Chirillo Associates
(206) 643-7631

Panel SP-4, Design/Production Integration

The objective of this new program area is to assist U.S. shipyards to reduce cost and decrease the time between contract award and delivery through the full integration of the design and production function, with design being considered the first step in the production sequence.

Chairman: F. Baxter Barham, Jr. of Newport News Shipbuilding
(804) 380-4343

Panel SP-5, Human Resource Innnovations

The objectives of this new program are to develop, test, and diffuse new management practices and organizational forms which better tap the potential of shipbuilding human resources. Its membership is drawn from the ranks of shipbuilding management and labor. With their technical shipbuilding background, panel meders will serve to convert academic theory into usable practical knowledge.

Chairman: Frank Long of Bethlehem Steel, Marine Construction Div.
(215) 694-6814

Program Manager: Michael E. Gaffney, New York State School of Industrial and Labor Relations, Cornell University.
(607) 256-3266

Panel SP-6, Shipbuilding Standards and Specifications

The objective of this program is to establish shipyard plans and priorities for the development and implementation of national shipbuilding standards. Draft shipbuilding standards produced under the panel are submitted to the American Society for Testing and Materials (ASTM), and developed, into National Consensus Shipbuilding Standards.

Chairman: Joseph R. Phillips of Bath Iron Works Corporation
(207) 443-3311, extension 2157

Panel SP-7, Welding

The objective of this program is to improve welding productivity through development of improved welding technology, techniques, and equipment. The program is intensely interactive with the equipment vendors and coordinates projects closely with the USCG and ABS. The program also works with independent welding laboratories in identifying advanced welding processes, fabrication problems, and new materials for welding.

Chairman: B. C. However of Newport News Shipbuilding
(804) 380-2394

Panel SP-8, Industrial Engineering

The objective of this panel is to improve productivity of Us. shipyards through: promotion of increased use of industrial engineering technology; training programs in I.E. technology (and its implementation in the industry) for members of management, supervisory staff and the workforce. The panel also develops specific I.E. programs to effectively implement new production control and manufacturing systems into new construction and repair yards.

Chairman: Joseph R. Phillips of Bath Iron Works Corporation
(207) 443-3311, extension 2157

Panel SP-9, Education

The objective of this panel is to coordinate the development and emplacement of programs for education in the range of technical skills required to improve shipyard productivity. This includes technician training, middle management refresher training, and higher education initial-entry professional training.

Chairman: Howard M. Bunch of the University of Michigan
(313) 764-6503

Panel SP-10, Flexible Automation

The flexible automation panel has the responsibility to act for the industry in coordinating a cooperative technical program to: develop a "road map" for transferring existing and developingiapplying new flexible automation technology; establish a consensus priority list of high cost driver areas for target applications of this technology; and to conduct research projects in this area.

Chairman: James B. Acton of Todd Pacific Shipyards\L.A. Division
(213) 832-3361, extension 4571

Panel 023-1, Surface Preparation and Coatings

This panel is tasked to improve shipbuilding and repair productivity and quality of the product through research and development into the methods, equipment and products used in preparing surfaces and applying protective coatings.

Chairman: John Peart of Avondale Shipyards, Inc.
(504) 436-5314

GLOSSARY OF TERMS

BUDGETING - The process of determining what resources should be committed to a given task; an itemized inventory of probable expenditures for a given period.

PERFORMANCE MEASUREMENT - The process of determining the actual expenditures of resources and the actual accomplishment of work. (Often expressed as a percentage ratio) .

PLANNING - The process of selecting the course of action to be taken in order to achieve the objectives (in light of the forecasted opportunities and obstacles) .

SCHEDULING - The process of assigning calendar dates to a sequence of events.

NON-PROCESS FACTOR - A predictable, repeatable occurrence during a job that contributes nothing to the end product.

STANDARD DATA - As used in this guide, an element of a specific process developed from predetermined elemental times (or from parametric formulae) . (Often expressed in easy-to-use charts, formulas, etc.).

PROCESS STANDARD - A description and standard time for a single specific work process.

PRODUCTION STANDARD - A description and standard time for a single specific production job.

SCHEDULING STANDARD A description and predicted actual time for a collection of production jobs.

PLANNING STANDARD - A description and predicted actual time for several work packages, sometimes aggregated by ship system or by geographical area of the ship.

WORK MEASUREMENT - The process of using production standards to measure performance of an individual worker on a specific piece of work.

WORK PACKAGE - As used in this Primer, a work package usually covers work described on a single drawing (or portion of it) to be done by a single trade in a single geographical area of the ship or shop, typically requiring about 100 to 500 manhours and 2 to 10 weeks duration. (Sometimes called a work order).

PROJECT MANAGEMENT - Those responsible for the successful completion of a single contract.

TOP MANAGEMENT - Those responsible for the successful completion of all contracts.

ALLOWANCE - A time value consisting of a percentage of time by which the normal time is increased to accommodate justifiable causes or policy requirements.

KEY EVENTS A series of significant occurrences (usually 25 to 50) by which the overall progress of a construction or repair project is measured.

WORK MANAGEMENT MANUAL - A document containing all data concerning available facilities, methods used, relevant conditions, and standard data for a work situation.

SUB-OPERATION - Line item on the detailed method description sheet.

SUB-OPERATION DATA - A catalogue of times for the line items on detailed method description sheets.

TIME STANDARD - The result of having used a sub-operation work sheet to analyze a piece of work.

TMU - Time-Measurement unit used in predetermined motion time systems. 1 TMU = .00001 Hour = .0006 Minute = .036 Second. One minute represents about 1667 TMU .

REFERENCES

A. Bath Iron Works Corporation, A Manual on Planning and Production Control for Shipyard Use, September 1978.

B. Bath Iron Works Corporation, Improved Planning and Production Control, August 1977.

C. Bath Iron Works Corporation, Scheduling Standards Pilot Project, Summary Report, May 1982.

D. Bath Iron Works Corporation, Standard Data Application Guide, June 1981.

E. Bath Iron Works Corporation, Labor Standard Classification System, January 1982.